The Sixth edition of International Symposium on Dielectric Materials and Applications

ISyDMA'6

Calais- France

December 15-17, 2021

Organized by

Dynamics and Structure of Molecular Materials Unit
« UNITE DE DYNAMIQUE ET DE STRUCTURE DES MATERIAUX MOLECULAIRES: UDSMM »
University of Littoral-Côte d'Opale, France
IN COOPERATION WITH:
Catalysis and Solid-state Chemistry Unit
« UNITE DE CATALYSE ET CHIMIE DU SOLIDE : UCCS »
University of Artois, Lens, France
****
Laboratory of Ceramic Materials and Associated Processes
« *Laboratoire des Matériaux Céramiques et Procédés Associés: LMCPA* »
Hauts de France Polytechnic University, Maubeuge, France
****

Laboratory of Condensed Matter Physics
«Laboratoire de Physique de la Matière Condensée*: *LPMC »
University of Picardy Jules Verne, Amiens, France

****
Moroccan Association of Advanced Materials
Moroccan Society of Applied Physics

ISyDMA'6 Contacts:

Pr. TACHAFINE Amina and Pr FASQUELLE Didier, Chairs of ISyDMA'6
Littoral-Côte d'Opale University, Calais, France
+33 3 21 46 57 83
+33 6 32 28 02 98
isydma6@univ-littoral.fr

ISyDMA'6 Venue:

Amphithéatre C001
Centre Universitaire de la Mi-Voix, 50
Rue Ferdinand Buisson 62100 Calais.
France

For more information about ISyDMA Symposiums, please see :

https://www.isydma.com/
https://web.facebook.com/ISyDMASymposium/
https://www.youtube.com/channel/UCQK92VqFHkq9lQMIEoflJuw

Contents

Preface

The ISyDMA conference is an international event focused on recent developments in dielectric materials and their applications. It is aimed at PhD students, post-docs, researchers and engineers from public and private research organizations concerned with innovations in advanced dielectric materials for biomedical, biotechnological and industrial applications.

The conference is aimed at materials specialists, physicists, chemists, biologists and engineers engaged in fundamental and applied research on dielectric materials and their innovative applications.

ISyDMA is open to a large scientific community since it brings together between 150 and 200 researchers and industrialists of 20 to 25 different nationalities. This is the 6th edition, the previous having taken place in Kenitra and Rabat (Morocco) in 2016, in Bucharest (Romania) in 2017, in Beni-Mellal (Morocco) in 2018, in Amman (Jordan) in 2019 and in virtual in 2020 due to the current health context.

ISyDMA'6 is organized as conferences, oral communications and poster sessions. Oral presentations will be grouped by thematic session beginning with invited lectures proposed by the scientific committee or chosen among the submitted papers.
The works presented during the meeting will be published in the Conference Proceedings by Springer Nature.

Due to the success of the ISyDMA'3 Pre-Conference: First Moroccan Spring School on Advanced Materials, in Marrakech, Morocco from 15 to 17 April 2018, and the ISyDMA'4 Pre-Conference School in Irbid, Jordan, from 30 April – 1 May, 2019, we proudly present our call for the ISyDMA'6 Pre-Conference: International Summer School on Advanced Materials for Energy (ISSAME), which is held from 13 to 14 December 2021 in Saint-Omer, France . The scope of this Summer School is to familiarize students with the state of the art in advanced materials for energy. The target audience for the Pre-Conference School is graduate students and junior researchers (PhD students, postdocs).

In addition to the scientific program of these two events, the attendees have a chance to discover the beauty of Calais and the Opal Coast with their several historical monuments classified as World Heritage by UNESCO and the numerous port cities full of history and various resorts that offer a wide range of activities . The social program is extraordinary, reflecting the French sense of hospitality and generosity combined with fun, for the participants and their companions.

For the ISyDMA'6 committees

Pr. TACHAFINE Amina
Littoral-Côte d'Opale University, Calais, France
Chair of ISyDMA'

Sponsors

ulco Université Littoral Côte d'Opale	UNIVERSITÉ D'ARTOIS	Université Polytechnique HAUTS-DE-FRANCE	UNIVERSITÉ de Picardie Jules Verne
UDSMM	UCCS UNITÉ DE CATALYSE ET CHIMIE DU SOLIDE	Lmcpa Laboratoire des matériaux céramiques et procédés associés	LPMC Laboratoire de Physique de la Matière Condensée
Région Hauts-de-France	SCOSI SERVICE COMMUN DU SYSTEME D'INFORMATION Réalisation SCoSI - Pôle IPM Informatique Pédagogique Multimédia	CAPSO COMMUNAUTÉ D'AGGLOMÉRATION DU PAYS DE SAINT-OMER	
HTDS Hi-Tech Detection Systems	MICROVISION INSTRUMENTS	SETNAG GRAND CALAIS Terres & Mers	
A2MA Moroccan Association for Advanced Materials		Société Marocaine de Physique Appliquée Materials Moroccan Society of Applied Physics	

Scope and Topics

Presentations cover a broad range of topics from basic to applied sciences related to major issues such as energy, environment, biotechnology, electronics and optoelectronics.
The contributions organized in four sections will focus on the following topics:

Section 1 : Dielectric materials for electronics and photonics

- Dielectric, piezoelectric, pyroelectric, ferroelectric and multiferroic materials
- Ceramics, thin films, polymers, glasses, composites and nanostructures
- Impedance spectroscopy to electrochemical and dielectric phenomena
- Dielectric properties, polarization phenomena and applications
- Surface and interfacial phenomena
- Physics of space charge in non-conductive materials
- Space charge and its effects in dielectrics
- Advanced characterization
- Modeling and theory
- Applications of multiferroics

Section 2 : Applications of insulators

- High voltage insulation design using computer; based analysis
- Partial discharges in insulation: detection methods and impact on ageing
- Monitoring and diagnostic methods for electrical insulation degradation
- Electrical insulation in high voltage power equipment and cables
- Ageing, partial discharges and life expectancy of HV insulation
- Electrical conduction and breakdown in dielectrics liquids
- Gaseous electrical breakdown and discharges

Section 3 : Dielectric devices for biotechnological and industrial applications

- Biodielectrics for environmental applications and bioengineering systems
- Biomedical engineering
- Tunable microwave devices
- Electrical energy storage, supercapacitors, electrostatic capacitors, electrolysors, batteries
- Electrical energy generation, Solid Oxide Fuell Cell
- Nanodielectrics for Industrial applications
- Dielectrics for superconducting applications
- Measurement techniques
- Electrocaloric materials, Thermoelectrics, Photovoltaics

Section 4 : Emerging materials and devices

- Metamaterials
- Nanocomposite dielectric polymers
- New diagnostic applications for dielectrics
- New and functional dielectrics for electrical systems
- Topological insulators
- Composite materials
- Other related dielectric phenomena and techniques.

Committees

ISyDMA'6 Chairs

- TACHAFINE Amina : Littoral-Côte d'Opale University, Calais, France
- FASQUELLE Didier : Littoral-Côte d'Opale University, Calais, France
- DESFEUX Rachel : University of Artois, Lens, France
- COURTOIS Christian : Hauts de France Polytechnic University, Maubeuge, France
- GAGOU Yaovi : University of Picardy Jules Verne, Amiens, France
- ACHOUR Mohammed Essaid : Ibn Tofail University, Kenitra, Morocco
- OUERIAGLI Amane : Cadi Ayyad University, Marrakech, Morocco
- MABROUKI Mustapha : Soltan Molay Sliman Univ. Beni-Mellal, Morocco
- AIT ALI Mustapha : Cadi Ayyad Univeristy, Marrakech, Morocco
- LEBLANC Roger M. : University of Miami, Florida, USA
- VASEASHTA Ashok : International Clean Water Institute, Manassas, Virginia, USA

Organizing Committee

- ACHKAR Miriam : UDSMM, Littoral-Côte d'Opale University, Dunkirk, France.
- AIT-SAID Corinne : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- BOUSSOUALEM Yahia : UDSMM, Littoral-Côte d'Opale University, Dunkirk, France.
- BUCHARD Isabelle : LMPA, Littoral-Côte d'Opale University, Calais, France.
- CARRU Jean-Claude : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- CHAHIB Soukaina : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- CHAMBRIER Marie-Hélène : UCCS, University of Artois, Lens, France.
- COMPIEGNE Gaëlle : LISIC, Littoral-Côte d'Opale University, Calais, France.
- FARHAT Layla : UDSMM, Littoral-Côte d'Opale University, Dunkirk, France.
- FASQUELLE Didier : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- GAGOU Yaovi : LPMC, University of Picardy Jules Verne, Amiens, France.
- KRASINSKI Freddy : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- LEROY Gérard : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- PALANI Parthiban : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- RGUITI Mohamed : LMCPA, Hauts de France Polytechnic University, Maubeuge, France.
- ROPA Patrick : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- SHAH Asmita : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- SHISODIA Shivani : UDSMM, Littoral-Côte d'Opale University, Dunkirk, France.
- SINGH Dharmendra Pratap : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- TACHAFINE Amina, UDSMM, Littoral-Côte d'Opale University, Calais, France.
- TENTILLIER Nicolas : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- TRIPATHI Atul SM : UDSMM, Littoral-Côte d'Opale University, Dunkirk, France.
- YASSINE Hassan : UDSMM, Littoral-Côte d'Opale University, Calais, France.

International scientific committee

- ACHOUR Mohammed Essaid : LASTID, University Ibn Tofail, Kenitra : Morocco.
- AIT ALI Mustapha, Chemistry Department, Cadi Ayyad Univeristy, Marrakech, Morocco.
- AL OMARI Mohammed-Ali : Jordan University of Science and Technology, Irbid, Jordan.
- AL SOUD Yaseen : University of Al al-Bayt, Al-Mafraq, Jordan.
- ALONTSEVA Darya : East-Kazakhstan State Technical University, Ust-Kamenogorsk, Kazakhstan.
- ANDRZEJEWSKI Bartlomiej : Institute of Molecular of Physics, the Polish academy od sciences, Poznari, Poland.
- BANYS Jūras : Physics Faculty, Vilnius University, Vilnius, Lithuania.
- BARZINJY Azeez Abdullah : Department of Physics, Salahaddin University-Erbil, Kurdistan Region, Erbil, Iraq.
- BOUHAFS Benamar : LPT, Faculty of Science, Tlemcen University, Tlemcen, Algeria.
- BOUKHEIR Sofia : MAScIR, Rabat, Morocco.
- BROSSEAU Christian : Lab-STICC, European University of Bretagne, Brest, France.
- BUKA Agnes : Wigner Research Centre of the Hungarian Academy of Sciences, Budapest, Hungary.
- CHAIB Hassan : Research group materials and energy, Polydisciplinary Faculty of Ouarzazate, Morocco.
- CHAMBRIER Marie-Hélène : UCCS, University of Artois, Lens, France.
- CHEMSEDDINE Abdelkrim : Helmholtz Centre, Berlin, Germany.
- CHO Yasuo : Research Institute of Electrical Communication, Tohoku University, Sendai, Japan.
- COFFEY William T. : Trinity College Dublin, Dublin, Ireland.
- COSTA Luís Cadillon : I3N, University of Aveiro, Aveiro, Portugal.
- COURTOIS Christian : LMCPA, Hauts de France Polytechnic University, Maubeuge, France.
- CURRI Lucia : CNR-IPCF Bari Division, University of Bari, Bari, Italy.
- DA COSTA Antonio : UCCS, University of Artois, Lens, France.
- DAOUDI Abdelylah : UDSMM, Littoral-Côte d'Opale University, Dunkirk, France.
- DEPRIESTER Michaël : UDSMM, Littoral-Côte d'Opale University, Dunkirk, France.
- DESFEUX Rachel : UCCS, University of Artois, Lens, France.
- DHAR Ravindra : Materials Science Department, Allahabad University, Allahabad, India.
- EBER Nandor : Wigner Research Centre of the Hungarian Academy of Sciences, Budapest, Hungary.
- EL HASNAOUI Mohamed : LASTID, Faculty of Sciences, University Ibn Tofail, Kenitra, Morocco.
- EL MARSSI Mimoun : University of Picardy Jules Verne, Amiens, France.
- ELAATMANI Mohamed : LSMIA, Cadi Ayyad Univeristy , Marrakech, Morocco.
- ERTUGRUL Mehmet : Department of Nanoscience and Nanoengineering, Atatürk University, Erzurum, Turkey.
- FASQUELLE Didier : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- FATTOUM Arbi : Materials Environment and Energy Sciences Faculty of Gafsa, Tunisia.
- FERRI Anthony : UCCS, University of Artois, Lens, France.
- FRECHERO Marisa A. : INQUISUR- CONICET, Universidad Nacional del Sur. Bahía Blanca, Argentina.
- GAGOU Yaovi, LPMC : University of Picardy Jules Verne, Amiens, France.
- GRACA Manuel Pedro Fernandes : I3N, University of Aveiro, Aveiro, Portugal.
- HAMRAOUI Ahmed ; Biomedical UFR, University of Paris Descartes, Paris, France.
- JOUIAD Mustapha : LPMC, University of Picardy Jules Verne, Amiens, France.
- KAMANINA Natalia : VavilovState Optical Institute Saint-Petersburg, Saint-Petersburg, Russia.
- KAREIVA Aivaras : Department of General and Inorganic Chemistry, Vilnius University, Vilnius, Lithuania.
- KHENFOUCH Mohamed : Ibn Zohr University, Agadir, Morocco.
- KREMER Friedrich : Institute of Experimental Physics I, University of Leipzig Germany.
- LACHGAR Abdessadek : Wake Forest University, Department of Chemistry, Winston-Salem, USA.
- ŁAWNICZAK Pawel : Institute of Molecular Physic, Polish Academy of Sciences, Poznań, Poland.
- LEBLANC Roger : Department of Chemistry, University of Miami, Florida, USA.
- LEMEE-LE CALVEZ Nathalie : LPMC, University of Picardy Jules Verne, Amiens, France.
- LONGUEMART Stéphane : UDSMM, Littoral-Côte d'Opale University, Dunkirk,France.
- LORGOUILLOUX Yannick : LMCPA, Hauts de France Polytechnic University, Maubeuge, France.
- MABROUKI Mustapha : FST, Sultan Moulay Slimane University, Beni-Mellal, Morocco.
- MAMUNYA Yevgen : National Academy of Sciences of Ukraine, Kyiv, Ukraine.
- MANOHAR Rajiv : Physics Department, Lucknow University, Lucknow, India.
- MOUSA Marwan Suleiman : Dept. of Physics, Mu'tah University, Al-Karak, Jordan.
- NOGALES RUIZ Aurora : Instituto de Estructura de la Materia, Consejo Superior de Investigaciones Científicas, Madrid, Spain.

- OGWU Abraham Atta : D.Serikbayev East Kazakhstan State Technical University, Ust-Kamenogorsk, Kazakhstan.
- OUERIAGLI Amane : LPSCM, Physics Department, Cadi Ayyad Univeristy, Marrakech, Morocco.
- PETKOV Plamen : Laboratory of Thin Film Technology, Department of Physics, University of Chemical Technology and Metallurgy, Sofia, Bulgaria.
- PETKOVA Tamara : IEES, Bulgarian Academy of Sciences, Sofia, Bulgaria.
- PISSIS Polycarpos : Department of Physics, National Technical University of Athens, Athens, Greece.
- POPOV Cyril : Institute of Nanostructure Technologies and Analytics, University of Kassel, Kassel, Germany.
- RAHMOUN Khadidja : URMER, Abou Bakr Belkaid University, Tlemcen, Algeria.
- REMIENS Denis : IEMN-UPHF, Valenciennes, France.
- RGUITI Mohamed : LMCPA, Hauts de France Polytechnic University, Maubeuge, France.
- SAADOUNE Ismaël : LCME, FST Marrakesh, University Cadi Ayyad, Marrakech, Morocco.
- SAMMUT Charles V. : Department of Physics, Faculty of Science, University of Malta, Msida, Malta.
- SINGH Dharmendra Pratap : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- SORETO TEIXEIRA Silvia : I3N and Physics Department, Aveiro University, Aveiro, Portugal.
- STRICCOLI Marinella : CNR-IPCF Bari Division, University of Bari, Bari, Italy.
- TACHAFINE Amina : UDSMM, Littoral-Côte d'Opale University, Calais, France.
- TRIKI Asma : Department of Physics, LaMaCoP, Faculty of Sciences of Sfax, University of Sfax, Sfax, Tunisia.
- TRYBULA Zbigniew : Institute of Molecular Physics, the Polish academy of sciences, Poznari, Poland.
- TSIULYANU Dumitru : Department of Physics, Technical University, Chisinau, Moldova.
- TURKY Gamal : Microwave Physics and Dielectrics, National research Centre, Cairo, Egypt.
- VASEASHTA Ashok : International Clean Water Institute, Manassas, Virginia, USA.
- ZDANOWSKA-FRACZEK Maria : Institute of Molecular Physics, the Polish academy of sciences, Poznari, Poland.

French scientific committee

- CARRU Jean-Claude : UDSMM, Littoral-Côte d'Opale University, Calais.
- CHAMBRIER Marie-Hélène : UCCS, University of Artois, Lens.
- COURTOIS Christian : LMCPA, Hauts de France Polytechnic University, Maubeuge.
- DA COSTA Antonio : UCCS, University of Artois, Lens.
- DAOUDI Abdelylah : UDSMM, Littoral-Côte d'Opale University, Duinkerk.
- DESFEUX Rachel : UCCS, University of Artois, Lens.
- FASQUELLE Didier : UDSMM, Littoral-Côte d'Opale University, Calais.
- FERRI Anthony : UCCS, University of Artois, Lens.
- GAGOU Yaovi : LPMC, University of Picardy Jules Verne, Amiens.
- JOUIAD Mustapha : LPMC, University of Picardy Jules Verne, Amiens.
- LEMEE-LE CALVEZ Nathalie : University of Picardy Jules Verne, Amiens.
- LEROY Gérard : UDSMM, Littoral-Côte d'Opale University, Calais.
- LORGOUILLOUX Yannick : LMCPA, Hauts de France Polytechnic University, Maubeuge.
- RGUITI Mohamed : LMCPA, Hauts de France Polytechnic University, Maubeuge.
- SINGH Dharmendra Pratap : UDSMM, Littoral-Côte d'Opale University, Calais.
- TACHAFINE Amina : UDSMM, Littoral-Côte d'Opale University, Calais.

Executive committee

- ACHOUR Mohammed Essaid, Coordinator : Ibn Tofail University, Kenitra, Morocco
- OUERIAGLI Amane, Vice-coordinator : Cadi Ayyad Univeristy , Marrakech, Morocco
- MABROUKI Mustapha, Vice-coordinator : FST, Sultan Moulay Slimane Univ., Beni-Mellal, Morocco
- AIT ALI Mustapha, Vice-coordinator : Cadi Ayyad Univeristy , Marrakech, Morocco
- MESSOUSSI Rochdi : Ibn Tofail University, Kenitra, Morocco
- TOUAHNI Rajaa : Ibn Tofail University, Kenitra, Morocco
- TACHAFINE Amina : Littoral-Côte d'Opale University, France
- KHADIRI Mohyeddine : Faculty of Sciences Semlalia, Marrakech, Morocco
- CHAIB Hassan : Polydisciplinary Faculty of Ouarzazate, Morocco
- BOUKHEIR Sofia : Moroccan Foundation for Adv. Sci., Innovation and Res. (MAScIR), Rabat, Morocco
- KHENFOUCH Mohammed : Ibn Zohr University, Agadir, Morocco
- ARIBOU Najoia : Ibn Tofail University, Kenitra, Morocco
- KHEMMOU Nidal : Ibn Tofail University, Kenitra, Morocco

ISyDMA'6 Planning

<table>
<tr><td rowspan="4">Wednesday
December
15, 2021</td><td>Morning</td><td>8H-9H</td><td>9H -9H45</td><td colspan="2">9H45 -10H15</td><td>10H15-12H15</td><td>12H15-13H15</td><td>13H15-14H45</td></tr>
<tr><td></td><td>Registration</td><td>Opening Ceremony (Amphitheater C001)</td><td colspan="2">Welcome reception</td><td>Conferences: 1, 2, 3, 4 (Amphitheater C001)</td><td>Oral Presentations Onsite Session A (Amphitheater C001) & SessionB (Room B014)</td><td>Photo of ISyDMA'6 Group & Lunch</td></tr>
<tr><td>Afternoon</td><td colspan="2">14H45-16H45</td><td colspan="3">16H45-17H</td><td colspan="2">17H-19H</td></tr>
<tr><td></td><td colspan="2">Conferences: 5, 6, 7, 8 (Amphitheater C001)</td><td colspan="3">Coffee-break</td><td colspan="2">Oral Presentations Onsite Sessions C and D</td></tr>
<tr><td rowspan="4">Thursday
December
16, 2021</td><td>Morning</td><td colspan="2">8H30-10H30</td><td>10H30-11H</td><td colspan="2">11H00-13H30</td><td>13H30-14H30</td><td></td></tr>
<tr><td></td><td colspan="2">Registration & Conferences: 9, 10, 11, 12 (Amphitheater C001)</td><td>Coffee-break & Poster session (I)</td><td colspan="2">Oral Presentations Online Session VA (Amphitheater C001)
Oral Presentations Online Session VB (Amphitheater Parreau)</td><td>Lunch</td><td></td></tr>
<tr><td>Afternoon</td><td colspan="5">14H45-19H</td><td>19H30</td><td></td></tr>
<tr><td></td><td colspan="5">Visit: Grand site des Deux-Caps on the Opal coast and Nausicaa national sea center</td><td>Gala Dinner</td><td></td></tr>
<tr><td rowspan="4">Friday
December
17, 2021</td><td>Morning</td><td colspan="2">8H30-10H30</td><td>10H30-11H00</td><td colspan="3">11H00-13H40</td><td>13H40-14H45</td></tr>
<tr><td></td><td colspan="2">Registration & Conferences: 13, 14, 15, 16 (Amphitheater C001)</td><td>Coffee-break & Poster session (II) Onsite</td><td colspan="3">Oral and Poster Presentations Online Session OP-VC (Amphitheater C001)
Poster Presentations Online Session PP-VA (Amphitheater Parreau)</td><td>Lunch</td></tr>
<tr><td>Afternoon</td><td colspan="2">14H45-16H45</td><td>16H45-17H15</td><td colspan="3">17H15-18H45</td><td></td></tr>
<tr><td></td><td colspan="2">Conferences: 17, 18, 19, 20 (Amphitheater C001)</td><td>Coffee-break</td><td colspan="3">Awards & Closing (Amphitheater C001)</td><td></td></tr>
</table>

Program

<table>
<tr><th colspan="3">Wednesday 15 December, 2021</th></tr>
<tr><td>08:00-9:00</td><td colspan="2">Registration</td></tr>
<tr><td>09:00-09:45</td><td colspan="2">Opening ceremony</td></tr>
<tr><td>09:45-10:15</td><td colspan="2">Welcome reception</td></tr>
<tr><td>10:15-12:15</td><td colspan="2">Conferences:
1, 2, 3, 4
Amphitheater C001
Chairs : Prof. J.C. Carru and Prof. L.C. Costa</td></tr>
<tr><td>10:15-10:45</td><td colspan="2">Conference 1 (Conf 01)
Invited Speaker :
Prof. Didier FASQUELLE
Dynamics and Structure of Molecular Materials Unit (UDSMM)
Littoral-Côte d'Opale University, Calais
France
Study and Optimization of Functional Oxide Properties: From Prediction to dedicated Characterizations.</td></tr>
<tr><td>10:45-11:15</td><td colspan="2">Conference 2 (Conf 02):
Invited Speaker:
Prof. Yasuo CHO
Research Institute of Electrical Communication, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai
Japan
Nanoscale Domain Dynamics Characterization Using Local C-V Mapping</td></tr>
<tr><td>11:15-11:45</td><td colspan="2">Conference 3 (Conf 03):
Invited Speaker :
Prof. Friedrich KREMER
Institute of Experimental Physics I
University of Leipzig, Leipzig
Germany
Molecular dynamics in 1- and 2-dimensional nanometric confinement as studied by Broadband Dielectric Spectroscopy</td></tr>
<tr><td>11:45-12:15</td><td colspan="2">Conference 4 (Conf 04):
Invited Speaker :
Prof. Juras BANYS
Faculty of Physics, Vilnius University, Sauletekio 3, LT-10257 Vilnius
Lithuania
Peculiarities of dipolar ordering in mixed cation halide perovskites</td></tr>
<tr><td rowspan="3">12:15-13:15</td><td colspan="2">Oral sessions
Sessions A and B
Onsite</td></tr>
<tr><td>Session A
Amphitheater C001
Chair : Prof. R. BENZERGA</td><td>Session B
Room B014
Chair : Prof. J. Mustapha</td></tr>
<tr><td>12:15-12:30</td><td>OP-A1
Pierre VOISIN
HTDS</td><td>OP-B01
Vasily TROTSENKO
Synthesis, dielectric, Raman and IR spectroscopic studies of BiScO3 phase samples with a perovskite-type structure</td></tr>
</table>

12:30-12:45	**OP-A02** **Anthony FERRI** **Investigating the nanoscale physical properties of electroactive PVDF-based nanocomposites**	**OP-B02** **Amina DJEMMAH** **Processing high permittivity rutile TiO2 for all-dielectric metamaterials applications at terahertz frequencies**
12:45-13:00	**OP-A03** **Lavinia- P. CURECHERIU** **Role of composition on the electrocaloric properties of BaMxTi1-xO3 ceramics**	**OP-B03** **Asmita SHAH** **Coping the poor conductivity of organic semiconductor liquid crystals via carbon-dots dispersion**
13:00-13:15	**OP-A04** **Azeez A.BARZINJY** **Biosynthesis of Silver Nanoparticles and Their Applications in Harvesting Sunlight for Solar Thermal Generation**	**OP-B04** **Jamal BELHADI** **Control, quantification, and mapping of elastic strains in epitaxial ferroelectric BaZrO3/BaTiO3 superlattices**
13:15-14:45	**Photo of ISyDMA'6 Group & Lunch**	
14:45-16:45	**Conferences:** **5, 6, 7 and 8** **Amphitheater C001** **Chairs : Prof. R. DESFEUX + Prof. M. STRICCOLI**	
14:45-15:15	**Conference 5 (Conf 05)** **Invited Speaker :** **Prof. Ashok VASEASHTA** ***NJCU-State University of New Jersey, NJ*** ***USA*** **Electrospun Nanofibers of High Performance Electret Polymers for Tactile Sensing and Wearable Electronics**	
15:15-15:45	**Conference 6 (Conf 06)** **Invited Speaker :** **Prof. Marisa A. FRECHERO** ***GFQCIES, Departamento de Química – INQUISUR*** ***Universidad Nacional del Sur (UNS)- CONICET, Bahía Blanca*** ***Argentina*** **Complex permitivity method to determine the devitrification process in a glassy matrix.The correlation between the a.c. electrical behaviour and the non isothermal nucleation**	
15:45-16:15	**Conference 7 (Conf 07)** **Invited Speaker :** **Prof. Dumitru TSIULYANU** ***CIMAN Research Centre of Department of Physics, Technical University of Moldova, Chisinau*** ***Moldova*** **Physical – chemical properties of sulfur enriched As-S-Ge glasses related to middle-range order structure**	
16:15-16:45	**Conference 8 (Conf 08)** **Invited Speaker :** **Prof. Mohamed-Ali AL-AKHRAS** ***Department of Physics*** ***Jordan University of Science & Technology (JUST), Irbid*** ***Jordan*** **Novel therapeutic approach of using herbal nanopowder in Photodynamic therapy (PDT)**	
16:45-17:00	**Coffee-break**	
	Oral sessions	

	Sessions C and D Onsite	
17:00-19:00	**Session C** **Amphitheater C001** **Chair : Didier FASQUELLE**	**Session D** **Room B014** **Chair : Gerard LEROY**
17:00-17:15	**OP-C01** **Prof. Yasuo CHO** **Recording Medium Design Aiming at Realizing Ferroelectric Probe Data Storage**	**OP-D01** **Miriam ACHKAR** **Characterization of Samarium Doped Barium Titanate Electrocaloric Ceramics Prepared by Sol-Gel Process**
17:15-17:30	**OP-C02** **Marie-Hélène CHAMBRIER** **Ferroelectric state in α-Ln2WO6 polymorphs stabilized in thin film form**	**OP-D02** **Manal BENYOUSSEF** **Theoretical and experimental investigation of BFO-based nanomaterials for photocatalytic applications**
17:30-17:45	**OP-C03** **Leontin PADURARIU** **Modeling of the dielectric properties in ferroelectric-based composites by Finite Element Method**	**OP-D03** **Shivani SHISODIA** **Effect of Nanostructuring on Thermoelectric Properties of Polymer Nanocomposites**
17:45-18:00	**OP-C04** **Vasily TROTSENKO** **Local symmetry breaking and formation of low-symmetry phase in Sr0.97Ba0.03TiO3 ceramic and thin film studied by vibrational spectroscopy**	**OP-D04** **Soukaina CHAHIB** **Dielectric characterizations of BaSnO3 bulk ceramics and thin films**
18:00-18:15	**OP-C05** **Hassan YASSINE** **Study of the aging of Lithium-ion coin cells with impedance and noise measurements**	**OP-D05** **Mohamed Aymen BEN ACHOUR** **Piezoelectric properties of biobased poly(L-lactide) stretched films for energy harvesting applications**
18:15-18:30	**OP-C06** **Blandine FONTAINE** **Optimization of (Ba,Ca)(Zr,Ti)O3 lead-free piezoelectric ceramics properties by variation of the composition**	**OP-D06** **Gauthier LEFEVRE** **Morphological characterization of innovative GaN passivation: insights into Normally-off MOS Capacitors**
18:30-18:45	**OP-C07** **Parthiban PALANI** **Structural, morphological and frequency dependent dielectric properties of Sr1-xCaxTiO3 (0.30≤ x≤ 0.40) ceramics**	**OP-D07** **Atul Atul S M TRIPATHI** **Hybrid thin Film based Phototransistor Optimized by Dynamic Floating Film Transfer Method**
18:45-19:00	**OP-C08** **Hanadi BREISS** **Ultra-porous composites based on epoxy foam loaded with carbon fibers for microwave absorption**	
Thursday December 16, 2021		
08:30-10:30	**Registration** **&** **Conferences:** **9, 10, 11 and 12**	

<table>
<tr><td></td><td colspan="2">Amphitheater C001
Chairs : Prof. D. FASQUELLE & Prof. D. TSIULYANU</td></tr>
<tr><td>08:30-09:00</td><td colspan="2">Conference 9 (Conf 09)
Invited Speaker :
Prof. Rachel DESFEUX
Unité de Catalyse et Chimie du Solide (UCCS)
University of Artois , Lens
France
Nanoscale Ferroelectricity in Innovative Lead-Free Oxide Thin Films</td></tr>
<tr><td>09:00-09:30</td><td colspan="2">Conference 10 (Conf 10)
Invited Speaker :
Prof. Luis Cadillon COSTA
I3N and Physics Department
University of Aveiro, Aveiro
Portugal
Microwave radiation: applications in metrology and materials synthesis</td></tr>
<tr><td>09:30-10:00</td><td colspan="2">Conference 11 (Conf 11)
Invited Speaker :
Prof. Marinella STRICCOLI
National Research Council of Italy
Institute for Physical and Chemical Processes - Bari Division, Bari
Italy
Nanomaterials and their assemblies:
advanced functionalities towards technological applications</td></tr>
<tr><td>10:00-10:30</td><td colspan="2">Conference 12 (Conf 12)
Invited Speaker :
Prof. Mustapha AIT ALI
Molecular Chemistry Laboratory Coordination Chemistry and Catalysis Unit
Faculty of Sciences-Semlalia, Cadi Ayyad University, Marrakech
Morocco
Chemical synthesis of 2D-nanomaterials: Functionalized silicene and phosphorene</td></tr>
<tr><td>10:30-11:00</td><td colspan="2">Coffee-break
&
Poster session (I) : Onsite</td></tr>
<tr><td rowspan="2">11:00-13:30</td><td colspan="2">Oral Presentations : Online</td></tr>
<tr><td>Session VA
Amphitheater C001
Chair of session :
Prof. Luis Cadillon COSTA</td><td>Session: VB
Amphitheater Parreau
Chair of session :
Prof. Tamara PETKOVA</td></tr>
<tr><td>11:00-11:15</td><td>OP-VA01
Giacomo BUCELLA
Electronic structure of defected polyethylene for Schottky emission</td><td>OP-VB01
Nidal KHEMMOU
Effect of an additive organic A1 in improving the quality of nickel electroplating on brass</td></tr>
<tr><td>11:15-11:30</td><td>OP-VA02
Najoia ARIBOU
Thermal and Spectral Dielectric Properties of Polypyrrole/Polymethylmethacrylate Composites</td><td>OP-VB02
Khaoula Mzioud
Synergistic formulation from Allium Sativum essential oil and diethyl thiourea for corrosion inhibition of carbon steel in 0.5 M H2SO4 medium.</td></tr>
<tr><td>11:30-11:45</td><td>OP-VA03
Yassine NIOUA
Electric modulus spectroscopic studies of the dielectric properties in reduced Graphene Oxide loaded epoxy polymer</td><td>OP-VB03
Nouhaila FERRAA
The anti-corrosive property of apatite tricalcium phosphate on carbon steel in two acid media HCl 1M and H2SO4</td></tr>
</table>

	composites	**0.5 M**
11:45-12:00	**OP-VA04** **Yassine EL HASNAOUI** **Dielectric Resonator with a Novel Antenna geometry fed by a microstrip line for 5G applications.**	**OP-VB04** **Bhavna PAL** **Molecular simulations of dielectric and spectroscopic properties of 4-cyano-4'-pentylbiphenyl liquid crystal and their comparison with experimental findings**
12:00-12:15	**OP-VA05** **Zineb SAMIR** **Dielectric spectroscopy of melt-extruded polypropylene carbon nanofiber composites**	
12:15-12:30	**OP-VA06** **Marwa ZAHID** **Low temperature synthesis and characterization of barium stannate titanate powders**	
12:30-12:45	**OP-VA07** **Abdallah NAYAD** **New two-dimensional functionalized silicon dispersible nanosheets prepared by direct exfoliation of calcium disilicide**	
12:45-13:00	**OP-VA08** **Salma Kaotar HNAWI** **Investigation of Aloe Vera Latex used as Natural Dye in TiO2 based Heterojunction and Liquid-Electrolyte Dye Sensitized Solar Cells**	
13:00-13:15	**OP-VA09** **Faissal EL MANJLI** **From red phosphorus to 2D phosphorene: synthesis and characterization**	
13:15-13:30	**OP-VA10** **Youness HADOUCH** **Giant electrocaloric effect and high energy storage efficiency in lead free BCTSn ceramic elaborated by sol gel method**	
Friday December 17, 2021		
8:30-10:30	**Conferences:** **13, 14, 15 and 16** **Amphitheater C001** **Chairs of session: Prof. R. BENZERGA and Prof. M.A AL-AKHRAS**	
8:30-9:00	**Conference 13 (Conf 13)** **Invited Speaker :** **Prof. Nathalie LEMEE** ***Laboratoire de physique de la Matière Condensée, UR 2081, Université de Picardie Jules Verne, 33 rue Saint-Leu, 80039 Amiens*** ***France*** **Nanodomains in ferroelectric / dielectric superlattices : a key role in the structural and functional properties**	

9:00-9:30	**Conference 14 (Conf 14)** **Invited Speaker :** **Prof. Maria ZDANOWSKA-FRACZEK** *Institute of Molecular Physics Polish Academy of Sciences, Poznań Poland* **Kinetics of the Phase Transformation under Pressure Studied by Impedance Spectroscopy**
9:30-10:00	**Conference 15 (Conf 15)** **Invited Speaker :** **Prof. Cyril POPOV** *Institute of Nanostructure Technologies and Analytics (INA)* *Center for Interdisciplinary Nanostructure Science and Technology (CINSaT)* *University of Kassel, Kassel Germany* **Fabrication and Characterization of Single-Crystal Diamond Membranes for Photonic Devices**
10:00-10:30	**Conference 16 (Conf 16)** **Invited Speaker :** **Prof. Vid BOBNAR** *Condensed Matter Physics Dept., Jožef Stefan Institute, Jamova 39, 1000 Ljubljana Slovenia* **Nanostructured multiferroic Pb(Zr,Ti)O3–NiFe2O4 thin-film composites**
10:30-11:00	**Coffee-break** **&** **Poster session (II) : Onsite**

11:00 - 13:00	**Session OP-VC** **Oral Presentations Online** **Amphitheater C001** **Chairs : Prof. Y. CHO**	**11:00 - 12:00**	**Session PP-VA** **Poster Presentations: Online** **Amphitheater Parreau** **Chair : Prof. D. SINGH**
11:00 - 11:15	**OP-VC01** **Ilham BOUKNAITIR** **AC conductivity and dielectric response of carbon dots/PMMA nanocomposite materials**	**11:00 - 11:05**	**PP-VA01** **Afaak LAKOUADER** **Synthesis, structure, dielectric, and energy storage properties of Ba0.85Ca0.15Zr0.1Ti0.9O3 ceramics under large electric field**
11:15 - 11:30	**OP-VC02** **Zakia ARIBOU** **Effects of Additive in an Electrodeposition Bath on the Surface Morphologic Evolution of Electrodeposited Copper**	**11:05 - 11:10**	**PP-VA02** **Safia DRISSI** **Preparation and characterization of Cu2Fe1-xCoxSnS4 thin films via sol-gel method**
11:30 - 11:45	**OP-VC03** **Zineb GARGAR** **Electrical, and dielectric properties of Yttrium-doped BaTiO3 ceramics**	**11:10 - 11:15**	**PP-VA03** **Afaak LAKOUADER** **A comparative study of structural, electrical, and energy storage properties in lead-free BCZT ceramics: Influence of the reduced thickness of ceramics.**
11:45 - 12:00	**OP-VC04** **Soukaina SAISSI** **The improvement of mechanical properties of lead acid battery grids**	**11:15 - 11:20**	**PP-VA04** **Mohamed EL HASNAOUI** **Lead titanate ferroelectric thin films prepared by polymeric precursor method**
12:00 - 12:15	**OP-VC05** **Messaoud HAMOUDA** **The mechanism study of the breakdown**	**11:20 - 11:25**	**PP-VA05** **Najoia ARIBOU** **Investigation of dielectric properties of**

	process of air near the flashover discharge		water dispersion of reduced graphene oxide/water nanofluid composite
12:15 - 12:30	**OP-VC06** **Artyom PLYUSHCH** Composite multiferroics with phosphate ceramic as a matrix	11:25 - 11:30	**PP-VA06** **Victor BOEV** Ureasilicate organic-inorganic hybrids doped with heteropoly acid
12:30 - 12:45	**OP-VC07** **Sarunas SVIRSKAS** Dielectric relaxation in Ba(Ti1-xSnx)O3 solid solutions	11:30 - 11:35	**PP-VA07** **Martynas KINKA** Investigation of linker rotation dynamics in ZIF-8, ZIF-67 and ZIF-90 metal-organic frameworks using broadband dielectric spectroscopy
12:45 - 13:00	**OP-VC08** **Ekaterina POLITOVA** Dielectric properties of new lead-free oxide materials ceramics on the base of KNN and NBT perovskites	11:35 - 11:40	**PP-VA08** **Vania ILCHEVA** Encapsulation of TiO2 nanosized particles in ureasil organic–inorganic hybrid obtained by sol-gel method
		11:40 - 11:45	**PP-VA09** **S. ELMASSI** Optimisation of the density of copper oxide nanowires synthesized by the electrochemical technique followed by annealing
		11:45 - 11:50	**PP-VA10** **M. BOUSSETA** Effect of RF power and annealing on the structural, optical and morphological properties of RF-sputtered V2O5 thin films
13:00 - 13:40	**Session PP-VB** **Poster session (II)** **Online**		
13:00 - 13:05	**PP-VB01** **Ali BOUGHAROUAT** A comparison of polypropylene-surface treatment by AC corona and dielectric-barrier corona discharges in the air		
13:00 - 13:05	**PP-VB02** **Houssem EddineBOUSBA** Effect of different plasma working gas mixtures on the decontamination of fungus polluted water		
13:05 - 13:10	**PP-VB03** **Abdeslem BELDJILALI** Influence of the Metal/Dielectric Contact on the Reliability of the Insulation Electrical Systems		
13:10 - 13:15	**PP-VB04** **Saadia AFEISSA** A possible crosslinking behavior of crosslincable Silane-XLPE HV insulation under cyclic accelerated weathering aging		
13:15 - 13:20	**PP-VB05** **Hassan CHAIB** Electrical and optical properties of room temperature potassium niobate single		
13:20 - 13:25	**PP-VB06** **Abdellah HBAB** DFT investigation of structural, electronic and optical properties of lithium niobate in its		

	ferroelectric phase
13:25 - 14:45	**Lunch**
14:45 - 16:15	**Conferences: 17, 18, 19 and 20** **Amphitheater C001** **Chairs of session: Prof. M. JOUIAD & Prof. Y. CHO**
14:45 - 15:15	**Conference 17 (Conf 17)** **Invited Speaker :** **Prof. Roger M. LEBLANC** ***Department of Chemistry, University of Miami, Coral Gables, FL 33146 USA*** **Physicochemical Characterization of a Novel Carbon Nanomaterial: Carbon Dots**
15:15 - 15:45	**Conference 18 (Conf 18)** **Prof. Tamara PETKOVA** ***Institute of Electrochemistry and Energy Systems, Bulgarian Academy of Sciences, Sofia Bulgaria*** **Influence of synthesis route on morphology and conduction behavior of proton conducting electrolytes with perovskite-structure**
15:45 - 16:15	**Conference 19 (Conf 19)** **Prof. Ratiba BENZERGA** ***Univ Rennes, CNRS, IETR-UMR 6164, F-35000, Rennes France*** **Cork-based composites for microwave absorbing materials**
16:15 - 16:45	**Conference 20 (Conf 20)** **Prof. Asma TRIKI** ***Laboratory of Composites Materials, Ceramics and Polymers, University of Sfax Tunisia*** **Adhesion analysis of non-woven hybrid cotton fibers in unsaturated polyester by dielectric spectroscopy**
16:45 - 17:15	**Coffee-break**
17:15 - 18:45	**Awards & Closing**

Ref.	**List of Posters session (I) (Onsite)**
PS-C01	**Ratiba BENZERGA** **Electric field assisted dissolution of Al and Cu metal thin films**
PS-C02	**Ratiba BENZERGA** **Hybrid material to broaden the absorption bandwidth of a metamaterial absorber**
PS-C03	**Petar PERVAN** **Comparison of poled glass SIMS data with concentration profile simulations and corresponding refractive index**
PS-C04	**Frédéric DUBOIS** **Characterization of Liquid Crystals recovered from End-of-Life Liquid Crystal Displays using Dielectric Spectroscopy**
PS-C05	**Frédéric DUBOIS** **Dielectric properties of dispersions of nanoparticles in polymer/liquid crystal films**

PS-C06	**Ratiba BENZERGA** **High power microwave absorbers based on glass foam composites**
PS-C07	**Hanadi BREISS** **Effect of fiber length on microwave absorption frequency band of composites based on carbon fiber loaded epoxy foam**
PS-C08	**Antonio DA COSTA** **Fabrication of ferroelectric tunnel nano-junctions in P(VDF-TrFE) thin films with a fine control by Conductive-AFM**
PS-C09	**Antonio DA COSTA** **2D material dependence on the crystallization and ferroelectric properties in organic P(VDF-co-TrFE) thin films**
PS-C10	**Vesna BLAŽEK BREGOVIĆ** **Electric field assisted dissolution of Al and Cu metal thin films**
PS-C11	**Mégane LHEUREUX** **Microstructure and nanoscale piezoelectric properties in Ba0.85Ca0.15Ti0.9Zr0.1O3 (BCTZ) thin films grown by pulsed laser deposition**
PS-C12	**Cristina Elena CIOMAGA** **Study of the structural, dielectric and ferroelectric properties in Ba0.85Ca0.15Ti0.9Zr0.1O3 ceramics**
PS-C13	**Cristina Elena CIOMAGA** **The role of microstructure on dielectric properties of polymer-based composites: Experiment and modelling**

Abstracts

Plenary Talks

Conf 01

Study and optimization of functional oxide properties: from prediction to dedicated characterizations

D. FASQUELLE[A], P. PALANI[A], S. CHAHIB[A], A. TACHAFINE[A], G. LEROY[A]
[a] *Unité de Dynamique et Structure des Matériaux Moléculaires, Université du Littoral Côte d'Opale, 50 rue Ferdinand Buisson, 62228 Calais, France.*
Corresponding author: didier.fasquelle@univ-littoral.fr

In Europe, the RoHS directive (Restriction of Hazardous Substances) was the first in its gender. Indeed it was the first political decision to prohibit some hazardous substances. Amid these substances, lead is one of the majors because this inorganic material is responsible of many deceases of the digestive system and brain, and of some kinds of tumours. Accordingly, it is now necessary to implement materials without these prohibited or hazardous substances. Lead-free functional oxides can be dedicated to numerous applications. Every kind of oxide can be chosen and optimized for a specific industrial application. Among these lead-free oxides, doped barium titanates show an evident interest due to their pseudo-cubic perovskite structure. Indeed the microstructural and electrical properties of these functional oxides can be fine-tuned by an appropriate exchange in the A and/or B sites of the unit cell. Here a part of some studies will be presented.

Before the presentation of experimental results, prediction must be introduced. What is a prediction? A prediction is a statement about what you think will happen in the future. Effectively scientists are a part of the emitters of prediction because our common life is surrounded by predictions for weather, sales, climate, market trends and so on…

The first part of the presentation will be related to SCT ceramics and films dedicated to electrical energy storage (EES). Actually the goal is to use SCT for the manufacturing of electrostatic capacitors. Here the prediction is centred on the fact that SCT could show an anti-ferroelectric behaviour for some particular compositions. To our knowledge, this is still a prediction as it has not been demonstrated at the macroscopic level by an exhibition of an anti-ferroelectric polarization cycle. Additionally SCT could be also used for the manufacturing of high-Q capacitors for electronic devices. But here the road has already been paved [1-2].

The second part of the talk will be related to simulation tools. In this way, simulations can be very powerful for studying the effect of a chosen dopant on the oxide properties. Here another prediction was done: we can dope an oxide, a potential candidate for solar cell application, for decreasing its energy gap. Indeed a lower Eg is more suitable for photovoltaic conversion. Cobalt (Co) was used as a dopant to investigate its influence on the structural, electronic and optical properties of $BaSnO_3$ oxide by using density functional theory (DFT) within WIEN2K-code based on the generalized gradient approximation (GGA) and the modified Becke-Johnson exchange potential (mBJ). Calculations were performed for $BaSn_{1-x}Co_xO_3$ ceramics, x = 0, 12.5, 25, 37.5 and 50 % [3]. This last part effectively shows how theoretical studies and simulations can be used to predict properties and for tuning them. And of course, these predictions and calculations have a great interest because they are done before doing any experimental development. This is thus very powerful for guiding the experimental works.

References

[1] Thèse Hichan Ait Laasri soutenue à l'ULCO le 29/06/2018.
[2] H. Ait Laasri, D. Fasquelle, A. Tachafine, N. Tentillier, L. C. Costa, M. Elaatmani, A. Outzourhit and J.-C. Carru. Functional Materials Letters Vol. 11, No. 2 (**2018**) 1850005.
[3] S. Chahib, D. Fasquelle and G. Leroy. Materials Science in Semiconductor Processing. 2021. In processing.

Conf 02

Nanoscale Domain Dynamics Characterization Using Local C-V Mapping

HIRANAGA Y.[1], MIMURA T.[2], SHIMIZU T.[2], FUNAKUBO H.[2], CHO Y.[1]

[1] *Research Institute of Electrical Communication, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai, 980-8577, Japan*

[2] *School of Materials and Chemical Technology, Tokyo Institute of Technology, 4259 Nagatsuta-cho, Midori-ku, Yokohama, 226-8502, Japan*

Email : yasuocho@riec.tohoku.ac.jp & hiranaga@riec.tohoku.ac.jp

Nanoscale characterization of polarization switching behavior is important in the future development of piezoelectric and ferroelectric devices. Recently, we have developed a novel probe microscopy technique for local C-V mapping based on scanning nonlinear dielectric microscopy (SNDM). This method enables detailed analysis of dynamic polarization switching behavior beyond the conventional static domain observation.

An SNDM system has an LC oscillator probe, which enables local capacitance deviation to be detected with high sensitivity. In a conventional SNDM observation, an AC bias voltage below a domain switching voltage is applied to a sample, and a nonlinear response is detected to visualize the static domain structure. On the other hand, in the novel method, the response is measured with a large-amplitude AC bias above the polarization switching voltage. For ferroelectric films, C-V curves observed in this way draw a butterfly curve, as with macroscopic measurements. By analyzing such local C-V butterfly curves, various parameters related to polarization switching can be obtained.

In this presentation, we will introduce two application examples. The first example is the characterization of a bulk single-crystal $LiTaO_3$. In this example, we revealed that anomalous C-V curves were observed in the vicinity of domain boundaries. Such C–V curves are considered to reflect domain wall movement due to the electric field. The second example is the characterization of a HfO_2-based ferroelectric thin film. Since the prepared film had random grain orientations, the shape of the observed C-V curves varied depending on the position. Parameter extraction from the obtained dataset enabled to visualize the in-plane distributions concerning the net switchable polarization amount, the intrinsic coercive field, and the local imprint.

Keywords : *Ferroelectric thin film, Scanning probe microscopy, Domain dynamics, Lithium tantalate, Hafnium oxide*

Conf 03

Molecular dynamics in 1- and 2-dimensional nanometric confinement as studied by Broadband Dielectric Spectroscopy

F. KREMER
Institute of Experimental Physics I, University of Leipzig, Linnéstr. 5, 04103 Leipzig, Germany
Email : friedrich.kremer@physik.uni-leipzig.de

The question on what length-scale molecular and especially glassy dynamics of low molecular liquids and polymers takes place is of fundamental importance and has multifold practical implications. Recent results based on Broadband Dielectric Spectroscopy [1] for nanometric thin (≥5 nm) layers of a variety of polymers [2-6] and even for isolated chains [5] will be presented, delivering the concurring result that deviations from glassy dynamics of the bulk never exceed margins of +/-3 K *independent* of the layer thickness, the molecular weight of the polymer under study and the underlying substrate. - The experiments lead to the conclusions that glassy dynamics takes place on the length scale a few polymer segments (≤ ~ 1nm), while the conformation of the chain as a whole is strongly modified by the geometrical confinement [7].

References

1. Kremer,F., A. Schönhals (Eds.) *Broadband Dielectric Spectroscopy*, Springer, Berlin 2003
2. Kipnusu, W.K. et al., *ACS Appl. Mater. Interfaces*, **7**, 12328-12338 (2015)
3. Neubauer, N.et al., *Macromolecules*, **49**, 6101-6105 (2016)
4. Tress, M.et al., *Science*, **341,** 1371-1374 (2013)
5. Kremer, F. (Ed.) "*Dynamics in geometrical confinement*", Advances in Dielectrics, Springer 2014
6. Kremer, F. et al., *Journal of Non-Crystalline Solids,* **407**, 277-283 (2015)
7. Mapesa, E.U.et al. J. Phys. Chem. Lett. 12, 117-125 (2021)

Keywords: *Broadband Dielectric Spectroscopy; nanometric confinement; glassy dynamics, chain dynamics, adsorption*

Conf 04

Peculiarities of dipolar ordering in mixed cation halide perovskites

Juras BANYS[1], Sergejus BALCIUNAS[1], Mantas SIMENAS[1], Sarunas SVIRSKAS[1], Martynas KINKA[1], Vytautas SAMULIONIS[1], Robertas GRIGALAITIs[1], Andrius GARBARAS[2], Anna GAGOR[3], Miroslaw MACZKA[3], Adam SIERADZKI[4]

[1] Faculty of Physics, Vilnius University, Sauletekio 3, LT-10257 Vilnius, Lithuania.

[2]Mass Spectrometry Laboratory, Center for Physical Sciences and Technology, Sauletekio 3, LT-10257 Vilnius, Lithuania

[3]Institute of Low Temperature and Structure Research, Polish Academy of Sciences PL-50-950 Wroclaw, Poland

[4]Institute of Low Temperature and Structure Research, Polish Academy of Sciences PL-50-370 Wroclaw, Poland

Email: Juras.Banys@ff.vu.lt

The methylammonium (MA) lead halides $MAPbX_3$ (where X = I, Br, Cl) are popular perovskite materials among scientists and industry due to their perspectives in effective and cheap solar cells. During the past decade, the power conversion efficiency of cells based on these hybrid compounds exceeded more than 20%. A high performance of these materials results from several physical properties such as large absorption coefficient, optimal bandgap, long carrier diffusion length, low exciton binding energy, exceptional defect tolerance. However, a successful application of hybrid perovskite solar cells is mainly prevented by their lead toxicity and poor both thermal and water stability.

The most stable and efficient solar cells are obtained by using perovskites with mixed cations at the A-site. The most popular alternatives to MA are formamidinium and Cs^+ ions. A Dimethylammonium (DMA) cation has been introduced recently as an alternative A-site modification for these compounds. Several investigations have shown that during certain synthesis procedures high quantities of DMA may be unintentionally introduced into $MAPbI_3$ and $CsPbI_3$. These modifications stabilize the preferable cubic phase of $MAPbI_3$ and leads to the enhanced performance at ambient condition.

In the field of classical inorganic perovskites it is well known that mixing may significantly perturb structure of resulting compound. Thus, the long-range order can be suppressed and frustrated phases may appear. The dielectric permittivity behavior of lead halides seem to be especially informative for the performance of the perovskite cells, as their relatively high value of the dielectric permittivity results in a pronounced defect tolerance and low exciton binding energy. However, a complete understanding of mixing effects on the dielectric permittivity dynamics and structural phase behavior is still absent. Here, we present a multitechnique experimental study of the mixed hybrid perovskite $MA_{1-x}DMA_xPbBr_3$. Our results show that structural phase transitions are significantly suppressed even for a low substitution of the DMA cations. For higher DMA levels, the long-range dipolar order disappears and dipolar glass dielectric behavior dominates in the dielectric spectra.

Keywords: *Dielectric permittivity, halides, solar cell absorber*

`

Conf 05

Electrospun Nanofibers of High Performance Electret Polymers for Tactile Sensing and Wearable Electronics

Ashok VASEASHTA
International Clean Water Institute, Manassas, VA USA
Institute of Electronic Engineering and Nanotechnologies "D. Ghitu", Chisinau Moldova, and Institute of Biomedical and Nanotechnologies, Riga Technical University, Riga, Latvia

Email: prof.vaseashta@nanoknowledge.info

Bio-Derived Polymers exist in abundance and display diverse chemical compositions, tunable properties, such as high k-dielectric, processability, excellent biocompatibility and biodegradability, with no to minimum toxicity. Such features provide them with capability for futuristic ubiquitous application in networked wearable and tactile electronics as membranes and devices to efficiently scavenge and store operational power from their working environment. Based on our previous work on e-textile, force protection clothing, wearable electronics and electrospun nanofibers, we provide an overview of the recent progress and future applications in textile, e-textile, tactile sensing (sensors, actuators, transistors) and triboelectric devices (batteries, supercapacitors, triboelectric nanogenerators) fabricated using bio-derived natural materials. The diverse structures and fabrication processes of three typical biopolymers provide sustainable pathways that would enable viable self-powering schemes in societally-pervasive applications. Additionally, challenges and potential research opportunities are analyzed and described.

Keywords*: biopolymers; tactile; triboelectric; wearable; sensors; high k-dielectric*

Conf 06

Complex permitivity method to determine the devitrification process in a glassy matrix.The correlation between the a.c. electrical behaviour and the non isothermal nucleation.

Marisa A. FRECHERO
GFQCIES, Departamento de Química - INQUISUR, Universidad Nacional del Sur (UNS)-CONICET. Bahía Blanca, Argentina.
Email: frechero@uns.edu.ar

Even today, after many years of study, it is still not clear how to design a glass from its components to fully predict its electrical, thermal, and optical behavior. We could have an initial idea but by empirical comparison rather than by a formal model to support it. Fewest is what we know about the vitreous stability and how atoms spatial order changes the original glass *structure* and be altered by the perturbations to which it may be subjected such as light, temperature variations, pressure changes, chemical agents, environmental conditions, over time. The so-called structural relaxation arises from glass atoms rearrangements close to the glass transition as well as from the devitrification process and it is fundamental to understand these phenomena. Glass-ceramic materials require a strict control of the crystallization phenomenon either by controlling the cooling rate of a glass-forming liquid or by heating a previously prepared glass [1-3] and their properties depend on the processes that take place during their transformation from a glass-forming liquid or a glass parent. Non-isothermal analysis involves a quick determination and the theoretical basis for the phase-transformation kinetics are also related to the JMAK (Johnson–Mehl–Avrami–Kolomogoroff) model, which describes the isothermal crystallization processes. As no foreign particles are included in a homogeneous nucleation mechanism the homogeneous nucleation and crystallizations show a straightforward effect on its complex permittivity in a more sensitive way that a calorimetric scanning. In the present talk, it is explained relationship between the electrical behavior of a phosphate glassy matrix to the thermal devitrification phenomena. The relationship between the structural changes caused by the thermal aging and the resulting electrical response is interpreted through the *dc* conductivity -macroscopic electrical response, and *ac* permittivity -microscopic response. This knowledge is fundamental when glasses and glass-ceramics are considered to use for capacitors.

Conf 07

Physical - chemical properties of sulfur enriched As-S-Ge glasses related to middle-range order structure

TSIULYANU D.[1], KOZYUKHIN S.A.[2], CIOBANU M.[1]

[1] *CIMAN Research Centre of Department of Physics, Technical University of Moldova, bul. Dacia 41, MD-2060 Chisinau, Moldova*

[2] *Kurnakov Institute of General and Inorganic Chemistry RAS, Leninsky Pr.,31119991, Moscow, Russia*

Email : tsiudima@gmail.com

Ternary nonstoichiometric chalcogenide glasses in the As-S-Ge system along the tie-line $(GeS_4)_x$ $(AsS_3)_{1-x}$ have been synthesized and characterized by applying XRD analysis, material density and ultrasound propagation measurements. On the basis of the results obtained from density measurements, for each glass composition has been evaluated the molecular weight, average molar and atomic volumes as well as the compactness of the glassy structure. Alongside, the material densities together with experimentally measured velocity of ultrasound propagation in it were used for determination of longitudinal elastic modulus and its compositional dependence. Providing XRD halos analyses the special attention was paid to "first sharp diffraction peak (FSDP)" ascribed to middle range order (MRO) structure of the glassy material. It was revealed that the position of the FSDP nonlinearly shifts with composition change and a maximum of the diffraction angle is clearly derived for glasses comprising about 8 at.% Ge that is composition $(GeS_4)_{0,33}$ $(AsS_3)_{0,67}$. Applying the Bragg equation to the FSDP peak position of each composition the structural period between MRO domains and its compositional dependence were calculated. From these data followed that the mentioned glassy $(GeS_4)_{0,33}$ $(AsS_3)_{0,67}$ exhibits the minimal inner distance between domains. As these result correlate with compositional dependence of average molar volume, it was concluded that the glasses from the pseudo-binary system AsS_3 – GeS_4 containing around 8 at.% Ge have the most "packed" MRO structure. The further increasing of Ge concentration leads to rather sharply boosting of both the average molar volume and inner distance between MRO domains, although finally this increasing tends to saturation. Wherein, it was established that the velocity of the ultrasound propagation reveals the similar compositional dependence, which provides evidence of a direct influence of structural period of the MRO domains on acoustic properties of glassy materials. At that, the compositional dependence of longitudinal elastic modulus better correlates with compositional dependence of compactness of the glassy structure, which is associated with the free volume and flexibility of the glassy network. It was found that among glasses under investigation here the highest compactness and elasticity exhibits the composition $(GeS_4)_{0,17}$ $(AsS_3)_{0,67}$ that comprises 4 at% Ge. The results are explained in terms of deep structural transformation in the middle range order caused by molecular reorganization. The substitution of trifold coordinated As atoms by fourfold coordinated Ge ones leads to a non-monotonic modification of medium range ordering structure, which controls the physical properties, including the elastic ones of the glass.

Keywords: *Glasses, Chalcogenides, XRD, FSDP*

Conf 08

Novel therapeutic approach of using herbal Nano powder in Photodynamic therapy (PDT)

M-Ali H. AL-AKHRAS (AL-OMARI)
Bio-Medical Physics Laboratory, Department of Physics, Jordan University of Science & Technology (JUST), P.O. Box 3030, Irbid 22110, Jordan.
Email: alakmoh@just.edu.jo; alakmoh@hotmail.com

Photodynamic therapy (PDT) involves administration of tumor localizing photosensitizer agent that produces reactive oxygen radicals during light irradiation and ultimately leads to cell death. There are two well-defined mechanisms for generating cytotoxic species: the first mechanism produces free radicals or superoxide ions resulting from hydrogen or electron transfer; second mechanism is singlet oxygen ($^1O_2$) which generated via an energy transfer process that occurs during collision of excited sensitizer with oxygen. Many photosensitizers such as Photofrin, Hypericin, Lutetium Lexaphyrin, Protoporphyrin IX, Rose Bengal, Methylene Blue, Saffron, … etc., are already known and some of them are used in vivo. The need to search for natural photosensitizers such as some medicinal herbal materials as a drug substitute are recently received new interest. Moreover, Nano herbal products such as Nanocurcumin is currently used in vitro as a potential photodynamic therapy drug and remains a desirable therapeutic goal. Nano products extracted from herbal is found to be better quantum efficiency, reductions in toxicity and enhancing the killing rate.

Keywords: Photodynamic therapy; Natural photosensitizer; Nano herbal; Singlet oxygen; Nanocurcumin

Conf 09

Nanoscale Ferroelectricity in Innovative Lead-Free Oxide Thin Films

DESFEUX R., CHAMBRIER M.H., SAITZEK S., DA COSTA A., FERRI A.
Univ. Artois, CNRS, Centrale Lille, Univ. Lille, UMR 8181, Unité de Catalyse et Chimie du Solide (UCCS),
F-62300 Lens, France
Email: rachel.desfeux@univ-artois.fr

Many research groups in the world are hardly working on the development, synthesis and characterization of novel ferroelectrics to enhance functional properties for information storage, electronics and spintronics applications. These ferroelectrics include both organic and inorganic compounds. Regarding oxide inorganic materials and for environment, one of the objectives is to replace lead-based compounds such as $Pb(Zr_xTi_{1-x})O_3$ by lead-free compounds showing such as high ferroelectric performances.

In this talk, we will present inorganic oxide materials recently discovered, or/and highlighted, which reveal ferroelectricity at room temperature when they are grown in the form of thin film. We will particularly focus this presentation on $Ln_2Ti_2O_7$ lanthanide dititanates with double-perovskite structure and Ln_2WO_6 lanthanide tungstates. We will demonstrate that strains induced by the substrate in the film can stabilize ferroelectric metastable phases. Besides, piezoresponse force microscopy is known as a powerful technique which permits to access to the domains pattern of ferroelectric sample while its spectroscopic tool yields information about switching properties (ferroelectric properties) and electromechanical activity (piezoelectric properties) at the sub-micron level. We will demonstrate that carefully well-defined experiments have to be achieved to avoid any misinterpretation about existence of ferroelectricity. Some examples of non-ferroelectric compounds, such as $Nd_2Ti_2O_7/SrTiO_3$ superlattice, will be reported. Phenomena explaining the non-ferroelectric behaviour in samples will be specified.

We will conclude this presentation by showing that the fabrication of new artificial hybrid materials combining designed inorganic lead-free ferroelectric thin films and electro-active organic polymers can be promising for the emergence of new attractive applications.

Conf 10

Microwave radiation: applications in metrology and materials synthesis

Luís Cadillon COSTA
I3N and Physics Department, University of Aveiro, 3810-193 Aveiro, Portugal
Email: kady@ua.pt

Different applications based on microwave radiation can be cited, depending on the power radiation level. For low power levels, in the order of mW, it can be used for the measurement of the electrical properties of materials. The measurement of the complex permittivity can be made using the small perturbation theory. In this method, the resonance peak frequency and the quality factor of a cavity, which are perturbed by the insertion of a sample in the cavity, can be used to calculate the complex dielectric. For high power radiation levels, in the order of kW, it can be used in ovens. Using a multimode cavity, operating at 2.45 GHz, as the only heating source, it is possible to design a microwave oven. Controlling the radiation power, in each stage of the process, it can be produced a more homogeneous electromagnetic field, which is a critical problem in the sintering process using microwave radiation. In this talk, both approaches, low and high power radiations are presented, which can be graphically seen in two different applications in the next figure.

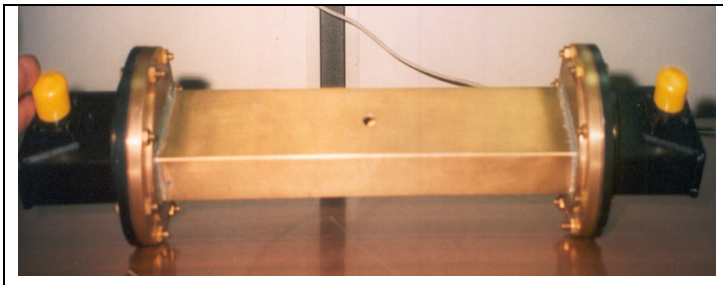


Figure- Resonant cavity for the measurement of the complex permittivity, and porcelain pieces synthesized in a high power microwave oven.

Conf 11

Nanomaterials and their assemblies: advanced functionalities towards technological applications

Marinella STRICCOLI
CNR-IPCF Bari, Via Orabona 4, 70125 Bari, Italy
Email: m.striccoli@ba.ipcf.cnr.it

In recent years, the term "nanomaterials" has almost monopolized the scientific language. At the nanoscale, materials present new and original properties. In this regime, the electronic structures can be tuned by varying the physical size of the nanocrystal (NC), leading to new phenomena, as surface plasmon resonance in metal nanoparticles (NPs) or size-dependent optical transitions in semiconductor quantum dots (QDs), opening interesting opportunities for their exploitation in technological applications. NCs synthesized by means of solution processes represent potential building blocks for cost effective manufacturing of photonic and optoelectronic devices, also on large scale. In particular, colloidal synthetic routes allow to control, in a reproducible manner, size, shape and crystalline phase of the nano-objects. The organic ligands that coordinate NCs play a key role, enabling a careful control on size and shape during the growth, preventing their aggregation, and allowing their versatile processing. By colloidal approaches, NCs of different composition (metal semiconductors, oxides, magnetic NPs, perovskite or carbon based QDs) can be prepared and functionalized with organic molecules which can be also modified after synthesis. Ultimately, the possibility to tune their surface chemistry allows to treat and manipulate the colloidal nanomaterials as macromolecules. The surface chemistry modification is widely exploited for the assembly of NPs, integrated in conventional functional systems or used to manufacture micro/nano devices, showing new properties due to the collective interactions among nanoparticles or with organic molecules [1]. As an example, QDs with controlled size can be coupled in dimeric systems, at nanometric and subnanometric distance, demonstrating efficient energy transfer or wavefunction delocalization processes, depending on their size and interparticle spacing [2,3]. In particular, the control of the geometric parameters of the assembly can strongly influence the coupling efficiency among the QDs and, accordingly, their electronic properties, with possible relapse in photonic or optoelectronic application.

References

1 Panniello A., Striccoli M. et al., Chem. Eur.J. 7(27) 2371(2021)
2 Dibenedetto, C.N., Striccoli M. et al., Nano Research, 13 (4), 1071 (2020).
3 Dibenedetto, C.N., Striccoli M. et al submitted.

Conf 12

Chemical synthesis of 2D-nanomaterials: Functionalized silicene and phosphorene

Mustapha AIT ALI

Laboratoire de Chimie Moléculaire : Unité de Chimie de Coordination et Catalyse Faculté des Sciences-Semlalia, Cadi Ayyad University, Marrakech, Morocco

Email: aitali@uca.ac.ma

The design of bi-dimensional (2D) materials has attracted a great attention for their remarkable physical proprieties in various technological applications. Since facile fabrication processes of large area nanosheets are required for practical applications, a development of soft chemical synthesis route without using conventional vacuum processes is a challenging issue. Techniques for the exfoliation of layered compounds are widely used to fabricate nanometer-thick materials, such as oxides, niobates, chalcogenides, phosphates, and graphene. Although a variety of nanosheets have been synthesized, there have been few reports of silicon and phosphor nanosheets. Mass production of silicon and phosphor nanosheets without conventional vacuum processes and vapor deposition can be achieved using low cost top-down approach starting from materials that comprise a 2D sheet structure as a fundamental unit. Chemical processes provide an alternative route to large-scale synthesis of 2D nanomaterials under production conditions.

Silicon Nano-sheets (SiNSs), low dimensional crystalline silicon materials with their high specific surface area, makes them promising candidates for a variety of applications in nanoscience and nanotechnology. There are two prominent types of SiNSs:

- buckled sheet mainly based on the Si (111) structure, with the same honeycomb lattice structure, but is corrugated due to sp^3 hybridization.
- silicene with a graphene-like honeycomb lattice structure and a mixed sp^3 -sp^2 hybridization, that is weakly corrugated.

On the other hand, black phosphorus (BP) was more recently introduced as a new member of the 2D layered material family; it is the most stable allotrope amongst the group also including white, red and violet phosphorus. Black phosphorus, with a graphite-like layered structure, can be effectively exfoliated up to the single atomic layer called phosphorene.

In this perspective, this work focuses on recent progress in soft chemical fabrication of 2D-nanomaterials:

- ✓ silicon nanosheets and their chemical modification,
- ✓ black phosphorus (BP) and it exfoliation to phosphorene.

Conf 13

Nanodomains in ferroelectric/dielectric superlattices: a key role in the structural and functional properties

Nathalie LEMEE

Laboratoire de physique de la Matière Condensée, UR 2081, Université de Picardie Jules Verne, 33 rue Saint-Leu, 80039 Amiens, France.

Email: nathalie.lemee@u-picardie.fr

Research on nanoscale ferroelectrics evidences that their behaviour is different from that in bulk ferroelectrics, in particular density of the domains and the domain walls increases and plays a key role in the functional properties. For fundamental physics, ferroelectric/dielectric superlattices constitute fascinating objects to understand ferroelectricity at the nanoscale, and to reveal new phenomena with potential for future devices. By alternating individual ultra thin ferroelectric layers with dielectric layers, it is possible to induce ferroelectric nanodomains[1] which are isolated from surface or film-substrate interfaces, and to change the electrostatic domain boundaries as well as the mechanical strain. The polarization discontinuity at the interfaces induces a depolarizing field, and the stability of the polar phase is preserved by forming stripe nanodomains of alternate up and down polarization.

In this talk, we will address some results which illustrate that the presence of ferroelectric nanodomains can lead to the emergence of new phase or can completely change the electric permittivity of a ferroelectric. We will show that a concomitant effect of strains and depolarizing fields in $PbTiO_3$, $PbZr_{0.2}Ti_{0.8}O_3$, $SrTiO_3$ tricolor superlattices can stabilize a monoclinic phase in $PbZr_{0.2}Ti_{0.8}O_3$ layers[2]. Combined with the electrostatic effect, the tensile strain induced by $PbZr_{0.2}Ti_{0.8}O_3$ in the $PbTiO_3$ layers leads to a polarization rotation associated with a monoclinic Mc phase. In $PbZr_{0.2}Ti_{0.8}O_3$ / $SrTiO_3$ superlattices, we will also show that the ferroelectric capacitance can be stabilized in the negative capacitance region[3]. Negative capacitance has been proposed as way of overcoming fundamental limitations on the power consumption of field-effect transistors[4], and therefore has recently attracted much attention. The negative capacitance was shown to be strongly related to the existence of ferroelectric nanodomains, in particularly, the domain wall motion greatly influences the dielectric properties of the heterostructure[5].

Keywords : ferroelectric materials, epitaxial superlattices, nanoscale, domain structure, strain and electrostatic effects, negative capacitance effect

References:

[1] M. Gharbi, C. Davoisne, F. Le Marrec, L. Dupont, N. Lemée, Disentangling elastic relaxation and ferroelectric domain contributions to in plane X-ray scattering profile : A necessity in strained ferroelectric superlattices, Mater. Lett. 275 (2020) 128138.

[2] N. Lemée, I.C. Infante, C. Hubault, A. Boulle, N. Blanc, N. Boudet, V. Demange, M.G. Karkut, Polarization Rotation in Ferroelectric Tricolor $PbTiO_3/SrTiO_3/PbZr_{0.2}Ti_{0.8}O_3$ Superlattices, ACS Appl. Mater. Interfaces. 7 (2015) 19906–19913.

[3] M. Gharbi, Etude de l'effet de capacité négative dans les super-réseaux ferroélectriques / paraélectriques, PhD thesis, Université de Picardie Jules Verne (2020).

[4] S. Salahuddin, S. Datta, Use of Negative Capacitance to Provide Voltage Amplification for Low Power Nanoscale Devices, Nano Lett. 8 (2008) 405–410.

[5] J. Íñiguez, P. Zubko, I. Luk'yanchuk, A. Cano, Ferroelectric negative capacitance, Nat. Rev. Mater. (2019).

Conf 14

Kinetics of the Phase Transformation under Pressure Studied by Impedance Spectroscopy

Maria ZDANOWSKA-FRĄCZEK, Łukasz LINDNER

Institute of Molecular Physics Polish Academy of Sciences, Poznań, 60-179, Poland
Email : mzf@ifmpan.poznan.pl

Knowledge of kinetics of phase transitions induced in condensed matter by pressure is vital because it allows the understanding of the phase transformation mechanisms and the processes that control the formation of phases with unique properties. A better understanding of these processes is the basis of the development of new materials suitable for target applications. The kinetics of the pressure-induced transformations has not been studied as extensively as the temperature-induced ones, mainly because of the difficulties related to high-pressure experiments. The present contribution's overriding objective was to determine whether subtle changes in proton dynamics generated by the pressure-induced structural changes are reflected in the ac conductivity spectra. The effect of various thermodynamic conditions (temperature and pressure) on the impedance spectra and electrical conductivity of superprotonic $(NH_4)_4H_2(SeO_4)_3$ (abbreviated TeAHSe) was investigated and discussed. The pressure effect on the ac conductivity spectra was similar to that caused by temperature, which means that both stimuli lead to an acceleration of protons' dynamics and, consequently, to an increase in conductivity. The P-T phase diagram of TeAHSe obtained for different temperatures in isobaric conditions is linear, in the pressure range of the experiment, with the pressure coefficient value dTs/dp=-0.023 K/MPa. It corresponds to the extension of the range of the superionic phase under the pressure impact.

This contribution also aims to determine the phase transition's kinetics in the TeAHSe crystal induced by external pressure. It has been established that the kinetics of this transformation can be described by the Avrami model with an effective Avrami index of about 4, which corresponds to the classical value associated with the homogeneous nucleation and three-dimensional growth of a new phase.

It should be emphasized that besides its usefulness to study the electrical inhomogeneity of the crystal at phase transition induced by an external stimulus, impedance spectroscopy can be a susceptible tool for studying complex microscopic behavior underlying the observed macroscopic response to the change in thermodynamic conditions.

***Keywords** : kinetics, Impedance Spectroscopy , pressure, ionics*

Conf 15

Fabrication and Characterization of Single-Crystal Diamond Membranes for Photonic Devices

HEUPEL J.[1], PALLMANN M.[2], KÖRBER J.[2], REITHMAIER J.P.[1], HUNGER D.[2], POPOV C.[1]

[1] *Institute of Nanostructure Technologies and Analytics (INA), Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Straße 40, 34132 Kassel, Germany*
[2] *Physikalisches Institut, Karlsruher Institute für Technologie (KIT), Wolfgang-Gaede-Str.1, 76131 Karlsruhe, Germany*

Email : popov@ina.uni-kassel.de

The development of quantum technologies is one of the big challenges in modern research and one of the most promising materials is diamond with its color centers in the crystal lattice. A crucial component for many applications is an efficient, coherent spin-photon interface. In order to yield an efficient outcoupling from the zero-phonon line of the color centers and improve the photon collection efficiency, various light-confining architectures can be used like Fabry-Pérot microcavities, nanopillars or photonic crystal cavities. They should be fabricated on thin single-crystal diamond (SCD) membranes with a good quality regarding not only the bulk material, but also its surface. We fabricated SCD membranes with various diameters, exhibiting a low surface roughness down to 0.4 nm on a small area scale, by etching through a diamond bulk mask with angled holes. A significant reduction of pits induced by micro-masking and polishing damages was accomplished by the application of alternating Ar/Cl_2+O_2 dry etching steps. By a variation of etching parameters regarding the Ar/Cl_2 step an enhanced planarization of the surface was obtained in particular for surfaces with a higher initial surface roughness of several nanometers. We present the successful bonding of a SCD membrane via van der Waals forces on a cavity mirror and perform finesse measurements which yielded values between 500 and 5000, depending on the position and hence on the membrane thickness. Furthermore, photonic crystals were structured in the SCD membranes by electron beam lithography and inductively coupled plasma reactive ion etching with SiO_2 hard mask.

Keywords : *Single-crystal diamond, Membranes, Roughness reduction, Nanophotonics*

Conf 16

Nanostructured multiferroic $Pb(Zr,Ti)O_3$–$NiFe_2O_4$ thin-film composites

Aleksander MATAVŽ,[1] Primož KOŽELJ,[1] Maximilian WINKLER,[2] Korbinian GEIRHOS,[2] Peter LUNKENHEIMER,[2] and Vid BOBNAR[1*]

[1]*Condensed Matter Physics Dept., Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia*
[2]*Experimental Physics V, Center for Electronic Correlations and Magnetism, University of Augsburg, 86159 Augsburg, Germany*
*E-mail: vid.bobnar@ijs.si

The synthesis of multiferroic composite materials rises as an alternative method for simultaneously obtaining ferroelectric and ferromagnetic properties at room temperature with a high degree of magnetoelectric coupling. Compared to bulk composites, thin-films exhibit unique advantages: their composition and connectivity can be modulated at the microscopic scale, which eventually leads to the artificial heterostructures with huge application potential in novel functional devices in the fields of sensors, data storage, and energy harvesters. In composites of spinel ferrites and ferroelectric ceramics – they have up to now been prepared as bulk ceramics or in thin-film configuration as bi- or multi-layers – the magnetoelectric effect arises from direct stress coupling between magnetostrictive (ferromagnetic) and piezoelectric (ferroelectric) grains. It is thus evident that good and extensive connectivity among the constituents might result in significant coupling between piezoelectric and magnetostrictive phases and enhance the magnetoelectric effects.

We present multiferroic thin-film composites with a novel morphology that in fact provides such an extensive connectivity between the magnetostrictive and piezoelectric constituents. They were fabricated by embedding the ferromagnetic $NiFe_2O_4$ into self-assembled highly-porous ferroelectric $Pb(Zr,Ti)O_3$ thin films (the latter themselves exhibit extremely interesting functional properties – the porosity-mediated release of the substrate's mechanical constraints namely boosts their piezoelectric response to the level of bulk ceramics [1]). Detailed structural investigations of developed composites revealed a two phase pure system, without any chemical reaction or solid solubility between both constituents during synthesis. The multiferroicity is clearly evidenced by detecting both ferroelectric and ferromagnetic hysteresis loops at room temperature. Detected magnetic field-induced changes of the dielectric constant, not only at low frequencies but also above the characteristic frequency of the Maxwell-Wagner behavior, reveal a direct stress coupling between the magnetostrictive $NiFe2O_4$ and piezoelectric $Pb(Zr,Ti)O_3$ grains and imply a great potential utility of the developed material in magnetocapacitive applications [2].

Keywords: *Nanostructured films, Thin-film composites, Multiferroics, Magnetoelectrics.*

[1] A. Matavž, A. Bradeško, T. Rojac, B. Malič, V. Bobnar, Self-assembled porous ferroelectric thin films with a greatly enhanced piezoelectric response, Applied Materials Today 16, 83 (2019).
[2] A. Matavž, P. Koželj, M. Winkler, K. Geirhos, P. Lunkenheimer, V. Bobnar, Nanostructured multiferroic $Pb(Zr,Ti)O_3$–$NiFe_2O_4$ thin-film composites, Thin Solid Films 732, 138740 (2021).

Conf 17

Physicochemical Characterization of a Novel Carbon Nanomaterial: Carbon Dots

Roger M. LEBLANC
Department of Chemistry, University of Miami, Coral Gables, FL 33146, USA
Author for correspondence: rml@miami.edu

Carbon dots (CDs) are a group of novel carbon-based spherical nanoparticles (NPs) with diameters less than 10 nm. They are widely present in the nature and can be also synthesized using various carbon-based substances as precursors by either top-down or bottom-up approaches. They are well characterized for tunable surface functionality, excellent photoluminescence (PL), high photostability and water dispersity, good biocompatibility, and nontoxicity. Also, they display different sizes and surface chemistry depending on the preparation methods and precursors applied. Applications of CDs in drug delivery, bioimaging, sensing, and other nanotechnology fields are rapidly rising due to their aforementioned unique properties. In addition, various spectroscopic and microscopic measurements have been performed on diverse CD preparations, which revealed some typical physicochemical features of CDs. For example, UV/vis absorption spectra of CDs usually display two peaks at 250 and 350 nm, which corresponds to C=C and C=O conjugate structures, respectively. Most fluorescence emission spectra have shown an excitation-dependent PL emission of CDs, which arouses a debate regarding the PL mechanism of CDs. The spherical morphologies of different CDs are studied through a combination of atomic force microscopy (AFM) and transmission electron microscopy (TEM) to obtain the three-dimensional data. As for the structural analysis of CDs, Fourier-transform infrared spectroscopy (FTIR), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy, X-ray diffraction (XRD), small-angle X-ray scattering (SAXS), and thermogravimetric analysis (TGA) have all been utilized to investigate the surface functionalities and core structures. Considering the abundant functionalities such as -COOH and -NH_2, distinct CDs were conjugated via an amidation reaction mediated by EDC and NHS to explore the construction of large multifunctional carbon-based nanostructures. Also, zeta potential studies show most CDs carry negative charge on the surface, which inspires numerous researches on the electrical or dielectric properties of CDs.

Keywords: *Carbon Dots, Physicochemical Characterization, Structure, Conjugation, Dielectric properties.*

Conf 18

Influence of synthesis route on morphology and conduction behavior of proton conducting electrolytes with perovskite-structure

PETKOVA T..[1], KOSTADINOVA O. [1], ZHELEV V.[1], DIMITROVA M. [1], PETKOV P.[2]

[1] *Institute of electrochemistry and energy systems, Bulgarian academy of sciences, 1113 Sofia, Bulgaria*

[2] *University of chemical technology and metallurgy, 1756 Sofia, Bulgaria*

Email : tpetkova@iees.bas.bg

Solid oxide fuel cells (SOFCs) are among the most promising devices running on renewable energy. The electrolyte as a part of the cell plays a crucial role in the cell function. The main requirements for electrolyte materials are: fast proton or mixed conductivity; chemical and mechanical stability in temperature range of operation. These characteristics depend largely on the composition and structure of the material, which in turn are highly sensitive to the method of synthesis. In search of fast conductive electrolytes operating at intermediate temperatures i.e. 300-700 ^{o}C, materials with perovskite structure and composition BaCe0.8-xTixLa0.2O3-δ, $0 \leq x \leq 0.3$ mol% are obtained by two different synthesis approaches: grinding and chemical precipitation reaction. Both regimes are finalized with high temperature sintering for 12 hours. The crystallographic structure is analyzed by X-ray diffraction. In order to reveal any possible differences on the molecular level, their structural arrangement was studied by ATR-Infrared spectroscopy. The results clearly show difference in the spectral characteristics of the materials prepared by the two methods. In addition, the morphology of the samples was studied. The conductivity is examined by electrochemical impedance spectroscopy. This method is very precise and sensitive to all changes that can occur in a material like structural transformations by varying the temperature or conditions (humidity). All the performed investigations in the present work show clear correlation between composition, structure and method of preparation.

Keywords: *materials characterization, dielectric materials, energy materials*

Conf 19

Cork-based composites for microwave absorbing materials

BENZERGA R.[1], KABALAN A.[1,2], MEJEAN C.[1], CHAULOUX A.[2] SHARAIHA A.[1]

1 Univ Rennes, CNRS, IETR-UMR 6164, F-35000 Rennes, France
France.

[2] CEA, Commissariat à l'Energie Atomique et aux énergies alternatives, Centre de Gramat, F-46500 Gramat, France.

Email: ratiba.benzerga@univ-rennes1.fr

Today, the microwave absorbers usually used in anechoic chambers are made from polymer matrix, such as polyurethane or polystyrene, which are produced by the petrochemical industry [1]. These materials are pollutants and their recycling is often very complicated.

In this work, we proposed an original material made from a bio-sourced matrix (cork) [2], acting as a support for the absorbing load (here carbon black). In addition to the rot-proof nature of this matrix and its thermal and acoustic insulation properties, the use of this material was motivated by two other properties: its low density and its fire resistance; two properties necessary for its use in anechoic chamber. In this work, the dielectric characterization of the materials, with different compositions in carbon black, is presented and revealed very interesting dielectric properties with regard to the intended application: namely a low permittivity associated with high dielectric losses. The simulation of pyramidal absorbers, using measured properties, is done in order to choose the best composition for the achievement of a pyramidal prototype. The measurement of the absorber prototype showed excellent absorption performance for a normal and oblique (30°) incidences of the electromagnetic wave. Very low reflection (Γ <-40 dB) is obtained over a wide frequency range (between 3.5 GHz and 17 GHz). The prototype of Bio-sourced based absorber also showed, for certain frequencies, better absorption performance than those of a commercial absorber with the same geometry. The temperature and power resistance of these absorbing composites are also studied by simulation and measurement. The results show a much slower rise in the temperature of our material than a commercial absorber one, based on polyurethane foam.

Keywords : *Bio-sourced composite, electromagnetic absorption, carbon particle, anechoic chamber, reflection loss.*

References

1. C. Méjean, L. Pometcu, R. Benzerga, A. Sharaiha, C. Le Paven-Thivet, M. Badard, P. Pouliguen, Materials Science and Engineering B, Volume 220 (2017) pp 59–65.
2. New electromagnetic-wave-absorbing materials for various applications, Patent References: FR1652428 / WO 2017162973 A1.

Conf 20

Adhesion analysis of non-woven hybrid cotton fibers in unsaturated polyester by dielectric spectroscopy

TRIKI A[1,*] , WANASSI B[2], BEN HASSEN M[2, 3] AND KALLEL A[1]

[1]*Laboratory of Composites Materials, Ceramics and Polymers, University of Sfax, Tunisia*
[2]*Laboratory of Textile Engineering, University of Monastir, Tunisia.*
[3]*College of Engineering, Industrial Engineering Department, Taiba University, Saudi Arabia*
[*] **Email**: trikilamacop@yahoo.fr

Dielectric measurements have been undertaken in the temperature range 0-150°C and the frequency range 0.1 Hz - 1 MHz on three non-woven hybrid cotton fibers reinforced unsaturated polyester composites (#1, #2 and #3). These latter differ either by the relative volume fractions of white yarns and indigo denim fabrics which are the constituents of the reinforcement or by the number of passages in the industrial needle punching for the mechanical consolidation of the non-woven reinforcement. The white yarns/indigo denim fabrics relative volume fractions 1:3 and 1:1, are used for the composites #1 and #2, respectively. Whereas, for the composite #3 which has the same relative volume fraction to the one for the composite #2 differs by the number of mechanical consolidation in comparison with the former composites. The dielectric analysis has revealed the presence of two interfacial polarization effects and the α relaxation at high temperature according to Kramers-Kronig relation. Analysis of these dielectric relaxations by means of the Havriliak-Negami model has evidenced the effect of the reinforcement constituent relative volume fractions and that of the mechanical consolidation on white cotton fibers/unsaturated polyester and indigo cotton fibers/unsaturated polyester adhesions. A comparative dielectric study allows probing the better reinforcement conception conditions for the better reinforcement/matrix adhesion.

Keywords : *Non-woven cotton fibers ; unsaturated polyester composites ; dielectric relaxation ; interfacial polarization effect.*

Conf 21

Ternary Germanium Containing Chalcogenide Glasses

P. PETKOV[1,*], T. PETKOVA[2]

[1] *Physics Department, University of Chemical Technology and Metallurgy, 1756 Sofia, Bulgaria*

[2] *Institute of electrochemistry and energy systems, Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria*

***Email**: p.petkov@uctm.edu

Bulk chalcogenide glasses of the $(GeSe_x)_{1-y}Ga_y$ and $(GeTe_x)_{1-y}Ga_y$ systems with Ga content (y) up to 20 mol.% are prepared with melt-quenched technique. The glassy properties – density, microhardness, compactness are determined as a function of the composition. Thermal characteristics: glass transition temperature (Tg), crystallization temperature (Tcr) and melting temperature (Tm) are obtained from the calorimetric investigations. The smooth increase in the characteristic temperatures in the glasses with gallium content reveals the stability of the investigated materials. The FIR spectra show reorganization in the glassy network after gallium introduction. The main tetrahedral structural units are partially substituted for chain-like structural units due to bonding of the gallium atoms with tellurium atoms. Apparently a peak related to a new-formed structure appears after introduction of additives into the tetrahedral chalcogenide structure. The stress in the films was measured by cantilever bending method. It was found that the Ge-Te-Ga films are under tensile stress which is higher for the films with higher Te content. The addition of gallium to the Ge-Se matrix affects the stress formation in the films: without gallium films possess negligible stress, while all gallium-containing films are under compressive stress. The increase of the gallium content leads to structural changes and an increase in the density, which results in higher stress values. The origin of the tensile stress could be sought in the difference of the atomic radii of the elements constituting the structural units of the glass. The spectral distribution of the refractive index variation depends on the addition of gallium in the films. The sign of the Δn has been found to convert from negative into positive. The irradiation of the thin films causes shift of the absorption edge. The peculiarity of the absorption edge and refractive index modulation could be explained with re-organization of the atomic structure due to floppy – rigid transition. The chain-like structure encourages the photoinduced structural transformations due to light illumination.

Keywords: *chalcogenides, glasses, optical properties*

Oral Presentations

(Session A)

OP-A02

Investigating the nanoscale physical properties of electroactive PVDF-based nanocomposites

FERRI A.[1], DA COSTA A.[1], DEFEBVIN J.[2], CHAMBRIER M.-H.[1], MARIN A.[2], BOURREZ R.[1], LEROY S.[1], BARRAU S.[2], LEFEBVRE J.-M.[2], DESFEUX R.[1]

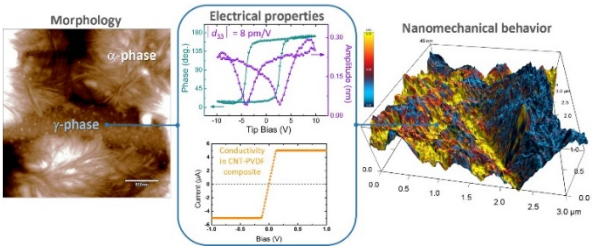
[1] *Univ. Artois, CNRS, Centrale Lille, Univ. Lille, UMR 8181 – UCCS – Unité de Catalyse et Chimie du Solide, F-62300 Lens, France*
[2] *Université Lille, Sciences et Technologies, CNRS, ENSCL, INRA, UMR 8207, Unité Matériaux Et Transformations (UMET), F-59655, Villeneuve D'Ascq, France*
Email: anthony.ferri@univ-artois.fr

Polymers with electroactive properties provide numerous opportunities for applications in domains such as biomedicine or energy generation owing to their low-coast, easy processing, flexibility, and biocompatibility compared to ceramic counterpart. The poly(vinylidene fluoride) (PVDF) is a semi-crystalline polymer with excellent piezo-, pyro- and ferroelectric properties allowing its application as sensors, actuators and flexible energy harvester systems. In addition, the inclusion of ceramic nanoparticles is an interesting way to improve physical properties of such fluoropolymers. Consequently, probing the response of the nanometric fillers dispersed in the polymer matrix becomes fundamental in order to optimize macroscopic performance of devices based on such piezocomposites. This crucial step thus requires the use of Atomic Force Microscopy (AFM) and their advanced modes, enabling to gain access to the physical properties of the nanocomposites with nanoscale resolution.

In the present study, both carbon nanotubes/PVDF and stretched barium titanate ($BaTiO_3$)/PVDF nanocomposites were studied. Based on several AFM modes, such as Tapping AFM for surface morphologies, Piezoelectric Force Microscopy (PFM) for piezo-/ferroelectric properties, conductive-AFM for electrical conductivity and amplitude modulation−frequency modulation (AM-FM) method for nanomechanical behavior, a deep investigation on the microstructure and physical properties of the composites was performed on the nanoscale in addition to macroscopic studies. The significant results are: (i) the direct identification of α- and γ-phases of the PVDF successfully achieved (Figure), enabling better understanding of the impact of the carbon nanotubes on the structural and functional properties of the PVDF-based nanocomposites [1]; and (ii) the ability of the PFM tool to directly image individual piezoelectric nanometric fillers embedded into a polymer matrix and control polarization as well [2], allowing for in-depth nanoscale study of electroactive composites.

[1] S. Barrau, A. Ferri, A. Da Costa, J. Defebvin, S. Leroy, R. Desfeux, J.-M. Lefebvre, *ACS Applied Materials & Interfaces* **10** (2018) 13092-13099.
[2] A. Ferri, S. Barrau, R. Bourez, A. Da Costa, M.-H. Chambrier, A. Marin, J. Defebvin, J.-M. Lefebvre, R. Desfeux, *Composites Science and Technology* **186** (2020) 107914.

Keywords: *PVDF-based nanocomposites; Nanoscale piezoelectricity; Atomic Force Microscopy*



The local behavior of PVDF γ-phase induced by carbon nanotube incorporation has been investigated by AFM-based techniques [1].

OP-A03

Role of composition on the electrocaloric properties of $BaM_xTi_{1-x}O_3$ ceramics

Lavinia CURECHERIU, Vlad-Alexandru LUKACS, Teodora MATEI, Leontin PADURARIU, Liliana MITOSERIU[1]

Dielectrics, Ferroelectrics & Multiferroics Group, Faculty of Physics, "Al. I. Cuza" University of Iasi, 11 Carol I Bv., 700506, Iasi, Romania

Email: lavinia.curecheriu@uaic.ro

In the last years, there is a high interest in developing alternative cooling technologies because: (i) it is important to reduce greenhouse gases that are used heavily in domestic and industrial refrigeration; (ii) high current densities in integrated circuits impose higher demands on cooling systems that cannot met by the fan-based solutions. The main advantage of electrocaloric (EC) refrigeration is that by comparison with magnetocaloric solid-state refrigerators based on another solid-state cooling technology, the big-sized magnet is still a drawback. $BaTiO_3$ (BT) family as EC materials has been studied quite extensively in the past several years in various forms including thin films, bulk ceramics (also multilayer ceramic capacitors -MLCC) and single crystals and a large ΔT has been reported for BT-ceramics in the vicinity of ferroelectric-paraelectric (FE-PE) (tetragonal-cubic T-C) phase transition. Owing to the high transition temperature the using of pure BT as EC materials is limited, but this can be properly modified by incorporation of suitable dopants. In the present work we proposed to study the composition dependence of ECE in $BaM_xTi_{1-x}O_3$ (M^{4+}=Zr/Hf) ceramics with composition from ferroelectric (x=0.02-0.08) to relaxor (x=0.20-0.30). Ceramics were obtained by sintering at 1500 ^oC the powders prepared by solid state method. X-ray diffraction data showed the phase purity and SEM images demonstrated homogeneous microstructures (average grain size between 10-5 μm) and well-defined grain boundaries. Impedance spectroscopy in the temperature range of (25 to 150)^oC shows a composition-induced ferroelectric-to-relaxor crossover with compositional-dependent shifts of the structural transition temperatures by comparison with ones of the pure $BaTiO_3$. Polarisation vs. E loops indicate regular variation with increasing M^{4+} addition, a reducing of loop area, remanent and saturation polarization (when M^{4+}=Zr from P_{sat}=15μC/cm^2 to P_{sat}=9μC/cm^2). ECE was indirect evaluated from P(E) loops with temperature and in case of Zr addition a maximum of 0.7 K was obtained for x=0.04 at 373K.

Acknowledgement: *This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS/CCCDI – UEFISCDI, project number PN-III-P1-1.1-TE-2019-1689, within PNCDI III*

Keywords*: $BaTiO_3$ solid solution, ferroelectric-relaxor crossover, electrocaloric effect*

OP-A04

Biosynthesis of Silver Nanoparticles and Their Applications in Harvesting Sunlight for Solar Thermal Generation

Azeez Abdullah BARZINJY[1,2] *

[1] *Department of Physics, College of Education, Salahaddin University-Erbil, Erbil, Iraq;*
[2] *Department of Physics Education, Faculty of Education, Tishk International University, Erbil, Iraq*

*Corresponding author: azeez.azeez@su.edu.krd

Silver (Ag) nanoparticles (NPs) have been synthesized through an easy, inexpensive, and ecofriendly method. *Petroselinum crispum*, parsley, leaf extract was utilized as a reducing, capping, and stabilizing agent, without using any hazardous chemical materials, for producing Ag NPs. The biosynthesized Ag NPs were characterized using different characterization techniques, namely UV-Vis, FT-IR spectroscopy, X-ray diffraction (XRD), X-ray Photoelectron Spectroscopy (XPS), dynamic light scattering (DLS), zeta potential, differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), transmission electron microscope (TEM), field emission scanning electron microscopy (FESEM), and energy-dispersive X-ray (EDX) analysis to investigate the optical, thermal, structural, morphological, and chemical properties of the plant extract and the biosynthesized Ag NPs. After that, the biosynthesized Ag NPs were utilized in harvesting sunlight for solar thermal generation. Surface plasmon resonance (SPR) for the green synthesized Ag NPs with the dark color were adjusted at nearly 450 nm. Once the Ag NPs are excited at the SPR, a large amount of heat is released, which causes a change in the local refractive index surrounding the Ag NPs. The released heat from the Ag NPs under the solar irradiation at the precise wavelength of plasmon resonance significantly increased the temperature of the aqueous medium. Different percentages of Ag NPs were dispersed in water and then exposed to the sunlight to monitor the temperature of the suspension. It was found that the temperature of the aqueous medium reached its highest point when 0.3 *wt.* % of Ag NPs was utilized. This investigation is rare and unique, and it shows that utilizing a small amount of the biosynthesized Ag NPs can increase the temperature of the aqueous medium remarkably.

Oral Presentations

(Session B)

OP-B01

Synthesis, dielectric, Raman and IR spectroscopic studies of $BiScO_3$ phase samples with a perovskite-type structure

V.G. TROTSENKO[1], A.Y. SEROVAISKII[2], V.G. KUTCHEROV[2], E.S.ZHUKOVA[1], A.A. BUSH[3], V.I. KOZLOV[3]

[1] *Moscow Institute of Physics and Technology (National Research University), 9 Institutskiy per., Dolgoprudny, 141701, Russia*

[2] *Federal State Autonomous Educational Institution of Higher Education «Gubkin Russian State University of Oil and Gas» (National Research University)», 65 Leninsky Prospekt, Moscow, 119991, Russia*

[3] *MIREA − Russian Technological University (RTU MIREA), 58 Vernadsky Avenue, Moscow, 119454, Russia*

Email : trotsenkovasily@gmail.com

The metastable $BiScO_3$ phase with a perovskite-type structure was obtained by thermobaric synthesis. Phase formation has been studied in a Bi_2O_3-Sc_2O_3 mixture fired at 800°C and subjected to thermobaric treatment at T = 800 - 1200°C, p = 6 - 7.5 GPa. It was found that the $BiScO_3$ phase with a perovskite-type structure is formed at T = 1000 - 1200°C, p = 6 - 7.5 GPa, the region of its stable existence at atmospheric pressure lies at T < 700°C. Single-phase samples synthesized at 1200°C and 7 GPa were investigated by FTIR spectroscopy in the temperature range of 5-450 K and by micro-Raman and dielectric measurements at T=80-700K.

As in the case of the related compound $BiMnO_3$, the bismuth scandate is considered in the context of the issue of its centrosymmetric monoclinic crystal structure, and specifically concerns the two space groups C_2 and $C_{2/c}$ [1]. The factor group analysis assumes 57 IR and Raman active modes in the case of a noncentrosymmetric group C_2, while for a centrosymmetric group $C_{2/c}$ the alternative prohibition rule is fulfilled - modes are active either in the IR spectra (27 modes) or only in the Raman spectra (30 modes) [2]. At 5 to 400 K, 48 modes were observed in the IR spectra, that is significantly larger than 27 predicted as by factor group analysis for the noncentrosymmetric space group C_2, while 24-26 modes appearing in the Raman spectra at T=80-400 K are more likely to correspond to the centrosymmetric group $C_{2/c}$. However, the weak contribution of additional lines to the IR and Raman spectra rather indicates a centrosymmetric structure with breaking the selection rules, which can be caused by disorder in the crystal structure or strong local polar distortions induced by the Bi^{3+} lone pairs. An anomalous behavior of the spectral response is observed when approaching 400 K. Many weak IR and Raman active phonons disappear, and the intensity of the Raman spectra begins to decrease, probably due to an increase of conductivity. Arguments in favor of several reasons for this behavior are analyzed: a) the presence of a structural phase transition or b) strong lattice anharmonicity and a large dynamic disorder of Bi cations. The pronounced anomalous changes in the temperature dependences of the dielectric constant ε(T) and the dielectric loss tangent tgδ(T) studied in the temperature range T = 10 - 350 K at frequencies f = 25 Hz - 1 MHz, not found. An increase in temperature causes a monotonic increase in the values of ε and tgδ.

The research was supported by the RFBR (Part of the works on the thermobaric synthesis of samples and the study of its dielectric properties in the low-frequency range) (project № 20-02-00915). V.G.T acknowledges RSF 2021(FTIR and Raman measurements) (project № 21-12-00358)

Keywords: *$BiScO_3$, Raman, FTIR-spectra, dielectric properties*

References

1. A. Belik et al. // $BiScO_3$: Centrosymmetric $BiMnO_3$-type Oxide//J. AM. CHEM. SOC. VOL. 128, NO. 3, 2006, p.706

2. V. Goian et al. // Absence of ferroelectricity in $BiMnO_3$ ceramics Journal of Applied Physics 112, 074112 (2012)

OP-B02

Processing high permittivity rutile TiO_2 for all-dielectric metamaterials applications at terahertz frequencies

DJEMMAH D.A [1], GEFFROY P.-M. [2], CHARTIER T. [2], ROUX J.-F. [3], BOUAMRANE F. [4], AKMANSOY E [1]

1 C2N, CNRS, UMR 9001, univ. Paris-Saclay, 10 bd T. Gobert, F91120 Palaiseau, France

2 IRCER, CNRS, UMR 7315, univ. de Limoges, 12 rue Atlantis, F87068 Limoges, France

3 IMEP, LaHC CNRS, UMR 5130, univ. Savoie Mont-Blanc, F73376, Le Bourget du Lac, France

4 UMPhy, CNRS-Thales, UMR 137, 1, Av. Augustin Fresnel, 91760 Palaiseau Cedex, France

Email : *eric.akmansoy@universite-paris-saclay.fr*

We aim to realize All-Dielectric Metamaterials (ADM) operating in the THz range[1]. ADMs are structured dielectric materials, whose unit cell comprises two sub-wavelength building blocks, that may be 2D or 3D. Indeed, ADMs rely on the first two modes of Mie resonances of High Permittivity Resonators (HPR). Their unit cell is of simple geometry. HPRs at a few tens of microns scale are required for ADMs applications in the Terahertz (THz) range.

THz radiation is widely defined as the electromagnetic radiation in the frequency range 0.3 -10 THz. It allows to obtain physical data that are not accessible by the means of X-rays or infrared radiation. Besides, ADMs allow to achieve a great number of fascinating phenomena, (see [2] for a review).

In this work, the dense TiO_2 ceramics with high permittivity and low dielectric losses has been obtained from powders by Spark Plasma Sintering method. We have studied the influence of the size of the grains, the temperature of SPS and the conditions of the post-annealing, on the dielectric properties of materials in the 0.3-1.5 THz range.

Then, the samples were characterized at THz frequencies by the means of Time Domain Spectroscopy. The optimized dielectric constant was measured in the 0.3-1.5 THz range: the relative permittivity ε' is around 100, while the dielectric losses linearly increase with frequency from tanδ = 0.01 to 0.1. These results are in good agreement with those of ref.[3] and are suited for the realization of ADMs. This behavior is also in good agreement with the semi-quantum model [4]. In a further step, this bulk ceramic will be micro-structured *via* micro-moulding so as to realize the ADMs. Polymer and quartz moulds will be etched. Our goal is to develop metadevices, i.e., efficient functional devices that take advantage of the fascinating properties of metamaterials.

Keywords: *Dielectric materials, THz-TDS, Metamaterials, low dielectric losses*

References

[1] Dupas C., Guillemet-Fritsch S., Geffroy P.-M., Chartier T., Baillergeau M., Mangeney J., Roux J.-F., Ganne J.-P. Marcellin S., Degiron A., Akmansoy E, High permittivity processed SrTiO3 for metamaterials applications at terahertz frequencies, Scientific Reports, 8, 15275 (2018)
[2] Jahani, Saman and Jacob, Zubin, All-dielectric metamaterials, Nature Nanotech, 11, 23–36 (2016)
[3] Naoki Matsumoto *et al* 2006, Terahertz Band-Pass Filter Fabricated by Multilayer Ceramic Technology, *Jpn. J. Appl. Phys.* **45** 7499
[4] Naoki Matsumoto *et al* 2008, Analysis of Dielectric Response of TiO in 2Terahertz Frequency Region by General Harmonic Oscillator Model, *Jpn. J. Appl. Phys.* **47** 7725

OP-B03

Coping the poor conductivity of organic semiconductor liquid crystals via carbon-dots dispersion

Asmita SHAH[1*], Redouane DOUALI[1], Sandeep KUMAR[3,4] , Abdelylah DAOUDI[2], Benoît DUPONCHEL[2] , and Dharmendra Pratap SINGH[1]

[1] *Unité de Dynamique et Structure des Matériaux Moléculaires (UDSMM), Université du Littoral Côte d'Opale, 62228 Calais France.*

[2] *Unité de Dynamique et Structure des Matériaux Moléculaires (UDSMM), Université du Littoral Côte d'Opale, 59140 Dunkerque, France.*

[3] *Raman Research Institute, Bengaluru- 560080 India.*

[4]*Department of Chemistry, Nitte Meenakshi Institute of Technology (NMIT), Yelahanka, Bangalore, India*

Email : asmita.shah@etu.univ-littoral.fr

Organic semiconductor liquid crystals (OSCLCs) have recently gained immense interest in the field of organic electronics. The 2,3,6,7,10,11-hexaoctyloxytriphenylene (HAT-8) discotic liquid crystal, exhibiting a hexagonal columnar (Col_h) phase, served as OSCLCs due to its appealing charge carrier mobility of the order of 10^{-4} $cm^2V^{-1}s^{-1}$ [1]. Often, these OSCLCs suffer from low conductivity, which restricts their use as an active material for organic devices [2]. To overcome this problem, we have dispersed carbon dots (C-dots) of size 7-8 nm (in diameter) to the host HAT-8 matrix into different concentrations. The HAT-8/C-dots composites have been characterized using dielectric spectroscopy, polarized optical microscopy and the time-of-flight technique. The dielectric results revealed that the conductivity of the pristine HAT-8 has been enhanced with the addition of C-dots as a function of their dispersion concentration (Figure 1). This enhancement in conductivity is attributed to the change in the molecular ordering of the discotic mesogens. The obtained results evince that the HAT-8/C-dots composites could serve better for organic electronic and optoelectronic applications.

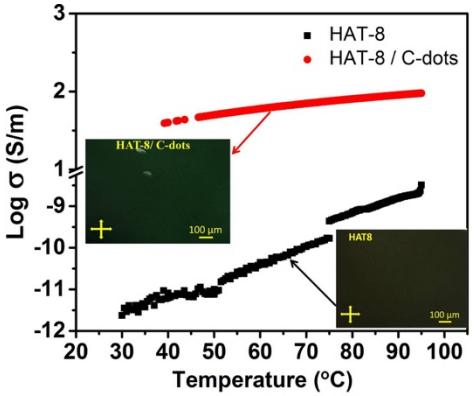


Figure 1. The variation of log σ as a function of temperature for the pristine HAT-8 and HAT-8/C-dots composite. Insets represent the corresponding polarized optical micrographs.

Key words: *Discotic Liquid Crystals, Carbon-dots, Mobility, Conductivity and Dielectric property*

References :

[1].A. Shah, D. P. Singh, B. Duponchel, F. Krasisnski, A. Daoudi, S. Kumar and R. Douali, J. Mol. Liq. 342 (2021) 117353.

[2].P. Mahesh, A. Shah, K. Swamynathan, D. P. Singh, R. Douali and S. Kumar, J. Mater. Chem. C, 8 (2020) 9252-9261.

OP-B04

Control, quantification, and mapping of elastic strains in epitaxial ferroelectric $BaZrO_3/BaTiO_3$ superlattices

J. BELHADI[1,*], F. RAVAUX[2], H. BOUYANFIF[1], M. JOUIAD[1], M. EL MARSSI[1]

[1]*Laboratory of Physics of Condensed Mater (LPMC), University of Picardie Jules Verne, Amiens 80039, France*

[2]*Materials Science Department, Masdar Institute at Khalifa University, 54224 Abu Dhabi, United Arab Emirates*

[*]*Corresponding author: jamal.belhadi@u-picardie.fr*

Ferroelectric superlattices (SLs) composed of alternating layers of different thin films are fascinating nanostructures that have attracted a great interest in the last decade, due to their superior physical properties suitable for many modern applications. The strain engineering is one of the tools giving rise to an enhancement of functional properties in SLs and usually leading to new ferroelectric properties. The strain is controlled by varying the SLs modulation period and the ratio of layer thicknesses of the alternating materials.

In this work, we present the control and quantification through strain mapping of the elastic strain in artificial $BaZrO_3/BaTiO_3$ (BZ/BT) superlattices grown on oxide substrates using pulsed laser deposition technique. The methodology consists of a combination of high-resolution scanning transmission electron microscopy and nanobeam electron diffraction associated with dedicated algorithm for diffraction patterns processing originally developed for semiconductors to record the strains at atomic scale. Both in-plane and out-of-plane elastic strains were then determined at 2 nm spatial resolution and their average values were used to map the strains along and transverse to the epitaxial growth direction to determine its variation along several BZ/BT interfaces. In addition, the variation of the width of the inter-diffusion BT/BZ interfaces and intermixing between different layers are estimated. The effect of the presence of inter-diffusion interfaces and the inherent elastic strains on the functional properties (dielectric, ferroelectric, energy storage, etc…) of the BZ/BT SLs are evaluated and discussed [1].

References :

[1]. J. Belhadi et al., Applied Surface Science, 512, 145761(2020).

Oral Presentations

(Session C)

OP-C01

Recording Medium Design Aiming at Realizing Ferroelectric Probe Data Storage

HIRANAGA Y. AND CHO. Y
Research Institute of Electrical Communication, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai 980-8577, Japan
Email : yasuocho@riec.tohoku.ac.jp & hiranaga@riec.tohoku.ac.jp

Ferroelectric probe data storage is a novel data storage method, which uses ferroelectric materials as a recording layer. In this method, digital data bits are recorded by nano-scaled polarization reversal. Extremely small domain dots (diameter of less than 10 nm) can be formed using ferroelectric thin films and nanoscale probe tip. Up to now, a domain dot array with an areal recording density of 4 Tbit/inch^2 has been written on a single-crystal $LiTaO_3$ recording medium to demonstrate its potential. This novel method, however, has a problem of low reading speed. Up to now, we have reported 3.7 Mbps readout demonstration using thin-film PZT recording media. Although this achieved readout speed is much higher than other probe data storage techniques, there is a significant gap between the current and the required specifications.

To overcome this problem, a novel ferroelectric recording medium with large nonlinear permittivity is required, because this data storage method uses the nonlinear dielectric response induced by small-amplitude ac bias to detect the bit data recorded in the form of polarization direction. Thus, we examined nonlinear permittivity based on phenomenological theory from the viewpoint of data storage application. We revealed that Curie-point control is one of the key techniques in material design for our application because nonlinear permittivity increases precipitously with approaching to the Curie temperature as with linear permittivity and piezoelectric constants. On the other hand, we also revealed that there is a trade-off relationship between nonlinear permittivity and polarization stability. To avoid this undesirable situation in data storage application, pinning-site control will also be important. Additionally, we also propose to employ a double-layer structure in the ferroelectric recording media for further improvement.

Keywords : *Probe data storage, Nonlinear permittivity, Phenomenological theory, $LiTaO_3$*

OP-C03

Modeling of the dielectric properties in ferroelectric-based composites by Finite Element Method

PADURARIU L.[1], CURECHERIU L.[1], CIOMAGA C.[1] AND MITOSERIU L.[1]

[1]*Dielectrics, Ferroelectrics & Multiferroics Group, Al. I. Cuza University of Iasi, Blv. Carol I, 700506, Iasi, Romania*

Email: leontin.padurariu@uaic.ro

Since single-phase ferroelectric materials cannot accomplish all the technological requirements in applications, developing composite materials that combine the properties of the ferroelectrics with other constituent phases (linear dielectrics, magnetic materials or other conductive/semiconductor components) is a commonly proposed solution. Recently, it has been shown by Finite Element Method simulations that a major factor that influences the effective properties of composite materials is the local electric field inhomogeneity introduced by the interfaces. Based on this effect, we proposed the original concept local field engineering which involves the design of materials with controlled microstructures and, implicitly, an optimum inhomogeneity of the electric field to improve the functional properties [1,2].

Another important factor that influences the functional properties of composites is the accumulation of free charges at interfaces, but this has been neglected so far because it involves important computational difficulties. In this work we propose a new modelling dynamic approach based on finite element method able to describe the complex impedance at any frequency in the range from 1Hz to 1MHz. The approach allows us to explore the influence of free electric charges on the effective dielectric properties of real composite systems. To demonstrate its generality, the new dynamic approach was implemented in this work to describe different types of ferroelectric-based composites: with conductive inclusions, magnetoelectric composites and porous ceramics.

Acknowledgements: This work was supported by the UEFISCDI Romanian projects PN-III-P1-1.1-TE-2019-1929 and PN-III-P4-ID-PCCF2016-0175.

Keywords: *Finite element method, Effective dielectric properties, Composites, Ferroelectrics*

References:

[1] L. Padurariu et. al., Appl. Phys. Lett. 100, 252905 (2012)
[2] L. Padurariu et. al, Acta Mater. 103, 724 (2016)

OP-C04

Local symmetry breaking and formation of low-symmetry phase in $Sr_{0.97}Ba_{0.03}TiO_3$ ceramic and thin film studied by vibrational spectroscopy

V.G. TROTSENKO[1], B. CARCAN [2], A.S. MIKHEYKIN[3], A.S. ANOKHIN[4], E. S. ZHUKOVA[1], M. EL MARSSI[2]

[1] *Moscow Institute of Physics and Technology (National Research University), Dolgoprudny, 141701, Russia*

[2] *Laboratory of Condensed Matter Physics, University of Picardy, 80039, Amiens, France*

[3] *Faculty of Physics, Southern Federal University, 344090, Rostov-on-Don, Russia*

[4] *Federal Research Center, Southern Scientific Center, Russian Academy of Sciences, 344006, Rostov-on-Don, Russia*

Email : trotsenkovasily@gmail.com

Quantum paraelectrics attract the attention of researchers due to both their applied and fundamental significance. The possibility of indicating polar and magnetic phases by creating defects, by cationic substitution and by mechanical stress, allows one to speak about the prospects of their use in various reconfigurable devices, sensors and memory elements. From a fundamental point of view, interest in quantum paraelectrics is caused by the specific features of phase dynamics, mechanisms of phase transitions, and exotic ground states. The aim of this study is to establish the effect of dipolar orderings on the oscillator parameters of lattice excitations and to reveal the role of various mechanisms and interactions in the formation of the phases in the vicinity of multiphase critical point T=48 K, x=0.029 on the phase diagram of $Ba_xSr_{1-x}TiO_3$ predicted by the phenomenological theory [1].

A thin (~ 100 nm) film of the $Sr_{0.97}Ba_{0.03}TiO_3$ solid solution was prepared by pulsed laser deposition on a MgO substrate. The ceramic sample used as a target was obtained by the solid-phase reaction method. Both samples were studied using X-ray diffraction, Fourier-transform infrared (FTIR), terahertz and Raman spectroscopy techniques. We discover differences in the temperature behavior of the spectral response of the thin film in comparison with the bulk ceramic sample, and a clear presence of a lower-symmetry phase. The spectral signature of the low-symmetry phase increases dramatically during cooling. In the Raman spectra of the thin film, IR-active lines are observed that are forbidden by the selection rules, indicating a local symmetry breaking and the appearance of polar nanoclusters at T = 150 K. These changes in the Raman response are accompanied by a shift of the ferroelectric soft mode towards low frequencies and by the appearance of additional absorption lines below T = 120 K in the IR spectra. A significant transformation of the spectral response with decreasing temperature is associated with the percolation of polar nanoclusters during the formation of low-symmetry phase [2]. However, the emergence at high frequencies, above 1000 cm^{-1}, of additional absorption lines in the Raman spectra cannot be explained by two-phonon processes and is probably a consequence of a more complex interaction of phonons at the boundaries of the Brillouin zone. Arguments in favor of the formation of phases predicted by the phenomenological theory [1] are discussed.

The research was supported by the RFBR (bulk sample synthesis, spectroscopic measurements of thin film and X-ray characterization of samples) (project № 17-02-01247) and MECOP (thin film synthesis). V.G.T and E.S.Z acknowledges RSF 2021(data analysis, spectroscopic measurements and chemical analysis of the bulk ceramic) (project № 21-12-00358)

***Keywords**: phase transitions, perovskite, polar nanoclusters*

References :

1. V. B. Shirokov et al. Phenomenological theory of phase transitions in epitaxial $Ba_xSr_{1-x}TiO_3$ thin films // PRB. 79, 144118 (2009)
2. A. Bencan et al. Atomic scale symmetry and polar nanoclusters in the paraelectric phase of ferroelectric materials // Nature Communications, 12, 3509 (2021)

OP-C05

Study of the aging of Lithium-ion coin cells with impedance and noise measurements.

H. YASSINE[1], G. LEROY[1], M. MASCOT[1], J.-C. CARRU[1]
[1] Unité de Dynamique et de Structure des Matériaux Moléculaires (UDSMM), Maison de la Recherche Blaise Pascal, Université du Littoral Côte d'Opale, 50 rue Ferdinand Buisson, 62228 Calais, France.
E-mail : Hassan.yassine@etu.univ-littoral.fr

In this work, we study the aging of lithium-ion coin cells by performing successive cycles of charging and discharging until the battery cannot be utilized. We perform different duration of discharging (and charging): short (30 mins), average (2h) and long (20h).

This study is carried out using the electric impedance and noise measurements in wide range of frequency typically from 0.01 Hz to 1 MHz. Figure 1 presents a complex impedance diagram $Z^* = Z' + i\,Z''$ under the form of $-Z'' = f(Z')$ parameterized in frequency. The first part, ranging from 0.01 Hz to 0.16 Hz, represents the diffusion of lithium ions in the battery. The second part (0.16 Hz to 88 kHz) depicts the electrochemical reactions taking place inside the battery. Finally, the values above 88 kHz constitutes the last part of the impedance spectrum, which reveals the artifacts of electric measuring wires (extrinsic effect of the battery).

In the context of this work, we notice that the aging leads to a strong increase of the resistance R_p but not in the resistance R_0. At the same time, the capacity (mAh) decreases strongly and tends towards 0 when the battery is out of order. In addition, noise measurements show the evolution at low frequencies of the noise level in $1/f^{\gamma}$ ($1<\gamma<2$).

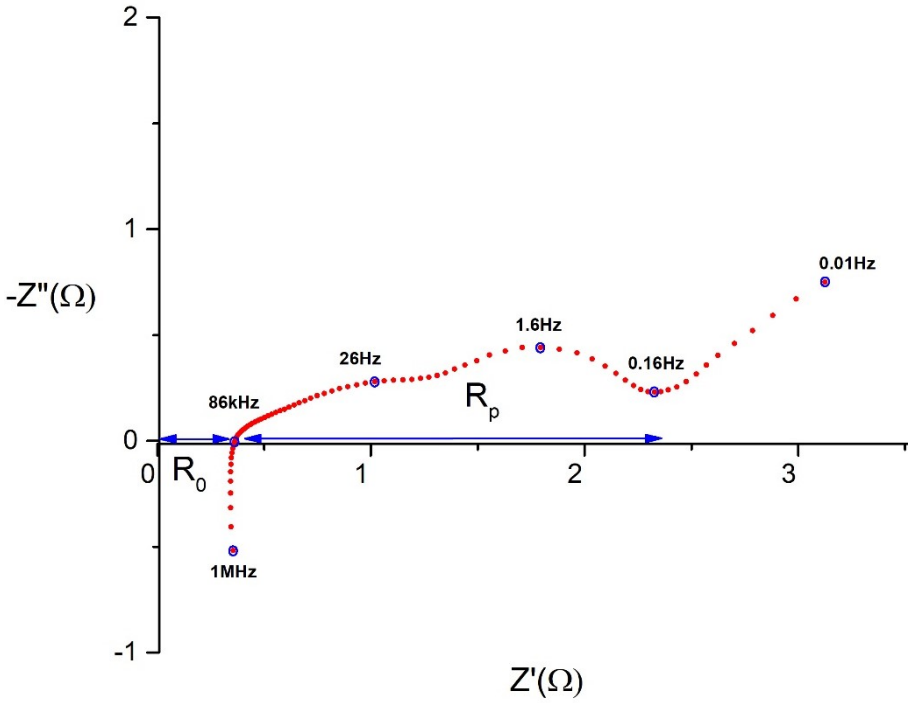


FIGURE 1: IMPEDANCE DIAGRAM FOR LITHIUM-ION CELL

Keywords: *Lithium-ion, Battery, Cycles, Impedance, Noise, Electrochemical reactions.*

OP-C06

Optimization of $(Ba,Ca)(Zr,Ti)O_3$ lead-free piezoelectric ceramics properties by variation of the composition

Blandine FONTAINE[1], Yannick LORGOUILLOUX[1], Mohamed RGUITI[1], Florian JEAN[1], Christian COURTOIS[1]

Univ. Polytechnique Hauts-de-France, EA2443, Laboratoire des Matériaux Céramiques et Procédés Associés (LMCPA), F-59313 Valencienne, France.

E-mail : Blandine.fontaine@uphf.fr

$PbZr_{(1-x)}Ti_xO_3$ (PZT) show piezoelectric properties (≈700pC/N) and a Curie temperature (≈ 360°C) much higher than other piezoelectric ceramics. Yet, PZT are associated to many health and environmental problems linked to the lead it contains. It is thus crucial to turn to so called "lead-free" ceramics. Among the alternatives, one is the family of barium and calcium zirconate-titanates $(Ba_{1-}xCax)(ZryTi_{1-y})O_3$ (BCTZ). These compounds have very promising piezoelectric properties, but a low Curie temperature. They have fewer applications than PZT but they can still be used at low temperatures as sensors or for energy harvesting, for example.

In this work, focus was first put on the composition $(Ba_{0.85}Ca_{0.15})(Ti_{0.90}Zr_{0.10})O_3$ as reference, and the Zr/Ti ratio (y/(1-y)) on one hand and the Ca/Ba ratio (x/(1-x)) on the other hand were then varied. The aim was to finely modulate the piezoelectric properties. Each composition was characterized by X-ray diffraction and scanning electron microscopy. The piezoelectric, ferroelectric as well as dielectric properties were also studied.

This work made it possible to highlight a d_{33} piezoelectric coefficient varying from ~250 pC/N to 450 pC/N, as well as a Curie temperature reaching 90°C for some compositions. The ferroelectric properties improve with when both x and y decrease, Pr attaining a maximum value of ~ 9.0 µc/cm² for x = 0.13 (y = 0.10) and ~ 9.1 µc/cm² for y = 0.08 (x = 0.15). Ps also shows maximum values of ~ 18.7 µc/cm² and ~ 18.8 µc/cm² for the same compositions.

Keywords*: BCTZ, X-rays powder diffraction, Ferroelectric materials, Dielectric materials, Piezoelectricity.*

OP-C07

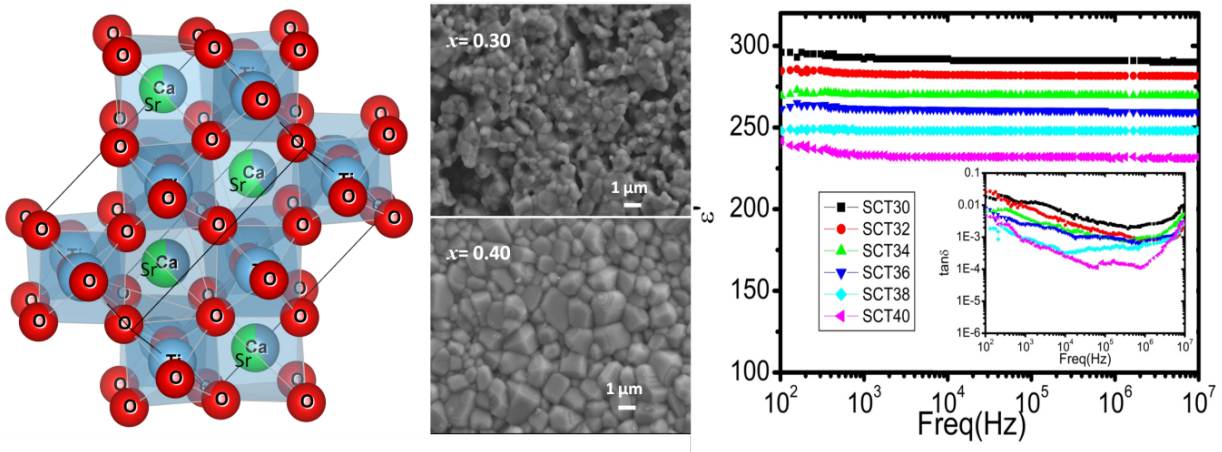
Structural, morphological and frequency dependent dielectric properties of $Sr_{1-x}Ca_xTiO_3$ ($0.30 \leq x \leq 0.40$) ceramics

PALANI P.[1], TACHAFINE A.[1] AND FASQUELLE D.[1]

[1] *Unité de Dynamique et Structure des Matériaux Moléculaires, Université du Littoral Côte d'Opale, 50 rue Ferdinand Buisson, 62228 Calais, France.*

Email: parthiban.palani@etu.univ-littoral.fr

In pulsed power circuits, dielectrics based electrostatic capacitors are indispensable components, resulting in a wide range of applications. The applications include but are not limited to energy storage, AC/DC converters of hybrid electric vehicles, medical devices, and military weapons [1]. Strontium calcium titanate (Sr,Ca)TiO_3 (SCT) solid solutions are a promising class of materials to design high-performance lead-free dielectric capacitors. This is primarily attributed to the fact that the Ca dopant irons the electric fields, temperature and frequency stabilities of $SrTiO_3$ ceramic. Here, we report the structural, microstructural and frequency (100 Hz to 10 MHz) dependent dielectric properties of sol-gel derived $Sr_{1-x}Ca_xTiO_3$ ($0.30 \leq x \leq 0.40$) ceramics. It has been found that the Ca doping concentration in the $SrTiO_3$ lattice played a significant role in structural, microstructural and dielectric evolution. The grain size increased (~0.8 µm to 2 µm) and the shape of the particles tends to be defined with an increase in Ca doping concentration. This implies that the grain growth is promoted with Ca^{2+} addition as a result of liquid phase sintering (growth is usually isotropic) [2]. The dielectric constant (ε') declined as the doping concentration increases (~290 to 230). This could be due to the lower atomic polarizability of Ca^{2+} (106 ± 4) than Sr^{2+} (197 ± 2) [3]. In the measured frequency range, the ε' of all samples has been found to be stable. This indicates that SCT ceramics possess good frequency stability. Dielectric loss tangent decreased down to $<2\times10^{-4}$ at 1 MHz frequency as the doping concentration increases. This is valuable for the dielectric materials in realistic applications.



Keywords: *Sol-gel, doping, lead-free dielectric ceramics and energy storage.*

Reference :

1. Ho, J., et al. (2010). *IEEE ElectricalInsulation Magazine*, *26*(1), 20-25.
2. Ali, A., Jameel et al (2021). *Materials,* 14(18), 5375.
3. Schwerdtfeger, P., & Nagle, J. K. (2019). *Molecular Physics*, *117*(9-12), 1200-1225.

OP-C08

Ultra-porous composites based on epoxy foam loaded with carbon fibers for microwave absorption

BREISS H.[1,2], EL ASSAL A.[1,2], BENZERGA R.[1], SHARAIHA A.[1], HARMOUCH A.[2], JRAD A.[2]

[1] *Univ Rennes, CNRS, IETR-UMR 6164, F-35000 Rennes, France*

[2] *Université Libanaise, EDST, Tripoli, Liban*

Email : hanadi.breiss@univ-rennes1.fr

Recently, a great progress has been reached in the development of new microwave absorber materials to meet the new requirements of different application domains. For a broadband frequency absorption, the porous composites are among the top absorber materials that gained much interest in the microwave domain.

In our team, a new electromagnetic (EM) absorber made from rigid epoxy foam filled with a very low concentration of carbon fibers (CFs) is developed. This solution has been proposed to overcome the inconvenient of the flexible polyurethane foam currently available and used in the anechoic chamber. Our results show a very good absorption performance for our materials compared with the commercial one; however, the density of the proposed material remains a constraint that must be optimized.

In this work, a simple method was proposed to fabricate lightweight CFs/epoxy foam composites with a very high EM absorbing performance; the composite density can be controlled via proper proportioning of components constituting the absorber material.

Samples with different densities and CFs loads are elaborated and characterized in free space in order to investigate the influence of these parameters on the structure and on the dielectric properties of composites. Our results show that the material density can be reduced by one third compared to the normal density of epoxy foam. In addition, the real part of permittivity of the elaborated composites is reduced, due to the presence of more porosity, while maintaining a very high level of dielectric losses, which is very promising for the elaboration of EM absorbing materials.

Finally, suitable properties that ensure an impedance gradient are selected to make a multilayer absorber prototype. The simulation and measurement of this very lightly loaded absorber were compared, in 2-16 GHz frequency band, to those of the dense CFs/epoxy foam multilayer and of commercial multilayer absorber.

Keywords: *Carbon fiber, dielectric materials, epoxy foam, lightweight composites, microwave absorption*

Oral Presentations

(Session D)

OP-D01

Characterization of Samarium Doped Barium Titanate Electrocaloric Ceramics Prepared by Sol-Gel Process

Miriam ACHKAR, Didier FASQUELLE, Abdelhak HADJ SAHRAOUI, Stéphane LONGUEMART

Unité de Dynamique et Structure des Matériaux Moléculaires, Université de Littoral Côte d'opale, Dunkerque, 59140, France.

Email : *miriam.p.achkar@gmail.com*

Vapor compression refrigeration is the most common refrigeration technology. However, it uses refrigerants that are harmful to the environment. As alternative solutions, several technologies based on solid state refrigeration are being developed. One of these alternatives is electrocaloric (EC) refrigeration. Electrocaloric effect (ECE) is a physical phenomenon present in polar materials and requires the application and removal of external electric field. This, results in an adiabatic reversible change of temperature or an isothermal variation of entropy [1]. Nowadays, the majority of the studied electrocaloric materials are ferroelectric, since they have a very important ECE near phase transition.

ECE is largely studied in ceramics. The most studied ceramics are of the perovskite (ABO_3) type, in particular lead-based materials. As the use of lead is being prohibited in a growing number of countries, these materials can be substituted by perovskite materials based on barium titanate ($BaTiO_3$), which are among the most well-known lead-free ferroelectric materials having excellent dielectric and ferroelectric properties [2].

Works on the ECE of $BaTiO_3$ doped with samarium (BTO-Sm) are very rare. To our knowledge, a single electrocaloric study on this compound has been reported with a single concentration of samarium (4%) [3]. Results showed that the substitution led to an important ECE coefficient ($\approx 0.3\ K.m/MV$). In the present work BTO-Sm was synthesized by sol-gel method with different samarium concentration ($0 \leq x \leq 0.06$). Structural, electrical, thermal and electrocaloric properties has been measured. Electrocaloric results showed that the substitution led to a decrease in the temperature at which the maximum ECE occurs and a widening of the temperature range where the ECE may be exploited.

Keywords: *Barium titanate, sol-gel, ferroelectrics, electrocaloric.*

References:

[1] Correia, T., & Zhang, Q. (2014). Electrocaloric materials. New Generation of Coolers, 34.

[2] Bai, Y., Ding, K., Zheng, G. P., Shi, S. Q., Cao, J. L., & Qiao, L. (2012). The electrocaloric effect around the orthorhombic-tetragonal first-order phase transition in BaTiO3. *AIP advances*, *2*(2), 022162.

[3] Han, F., Bai, Y., Qiao, L. J., & Guo, D. (2016). A systematic modification of the large electrocaloric effect within a broad temperature range in rare-earth doped BaTiO3 ceramics. Journal of Materials Chemistry C, 4(9), 1842-1849.

OP-D02

Theoretical and experimental investigation of BFO-based nanomaterials for photocatalytic applications

Manal BENYOUSSEF, Mimoun EL MARSSI, Mustapha JOUIAD
Laboratory of Physics of Condensed Matter (LPMC), University of Picardie Jules Verne, Scientific Pole, 33 rue Saint-Leu, 80039, Amiens Cedex 1, France
Email : manalbenyoussef@gmail.com

Harnessing sunlight to produce hydrogen on demand is regarded as an ingenious way to produce alternative clean energy and meet the world's energy needs. In recent years, perovskite materials have emerged as potential photocatalysts owing to their high electrochemical and photophysical properties allowing the design of water splitting devices with high solar to hydrogen efficiency. $BiFeO_3$ (BFO) material is regarded as a potential material for photocatalysis owing to its moderate band gap of 2.7 eV enabling visible light absorption, in addition to its ferroelectric properties which could be used to control the separation of the photogenerated charge carriers. However, the sole use of the BFO system as a catalyst limits its performances owing to its weak redox ability. Therefore, our approach is to use solid-solutions based on the BFO system to improve the catalytic performances. Furthermore, the design of nanomaterial catalysts has been reported to exhibit higher catalytic performances over their bulk counterpart owing to their increased specific surface area, and effective transfer rate of electrons-holes to the surface of the photocatalyst. Within this scope, the aim of the present work is to develop low-dimensional functional BFO-based materials having unique physical properties for applications related to hydrogen energy production. Two complementary approaches were used to choose and develop the optimal BFO-based composition presenting the best properties for photocatalysis. As a first stage, computational modeling and materials optimization were performed through first principles calculations to investigate the electronic, optical, and photocatalytic properties of different BFO-based materials. Then, and supported by theoretical results, their synthesis was performed through different techniques to elaborate composite materials having both band gap > 1.8 eV necessary to split water molecules, and intrinsic polarization to separate the generated charge carriers.

OP-D03

Effect of Nanostructuring on Thermoelectric Properties of Polymer Nanocomposites

SHISODIA S.[1*], HADJ SAHRAOUI A.[1], SINGH D.P.[2], DEPRIESTER M[1].
[1]*Unité de Dynamique et Structure des Matériaux Moléculaires, EA4476, Université du Littoral Côte d'Opale, Dunkerque, 59140, France*
[2]*Unité Dynamique et Structures des Matériaux Moléculaires, EA 4476, Université du Littoral Côté d'Opale, Centre Universitaire de la Mi-Voix, 62228, Calais, France.*
Email: shivani.shisodia@univ-littoral.fr

Thermoelectric (TE) materials are well known for their ability to convert waste heat into electricity[1]. So far, inorganic TE materials like Bi_2Te_3, PbTe, SnSe gained much attention due to their high TE *figure of merit* i.e. *zT* values. However, their low earth abundance, toxicity, high cost, and hideous processing make it difficult to serve large scale applications[2].

In order to achieve a high *zT* values, TE parameters, namely, electrical conductivity, thermal conductivity, and Seebeck coefficient are needed to be optimized. However, these parameters are interdependent on each other in the bulk state and a change in one parameters can have a huge impact on the other. Nevertheless, this interdependency vanished at nanoscale, which means nanostructuring of materials could be helpful to attain high zT[3].

We have synthesized poly (3,4-ethylene dioxythiophene): polystyrene sulfonate (PEDOT: PSS) matrix filled with graphene oxide-titanium dioxide (GO-TiO_2) nanostructure and the effect of nanostructure on the TE properties has been investigated. It has been evident that the GO-TiO_2 nanostructure succeed to break the interdependency by enhancing electrical conductivity and Seebeck coefficient in parallel to the decrement in the thermal conductivity and as a result, an improved *zT* values has been attained.

Keywords: *Thermoelectricity, nanostructures, thermal conductivity, electrical conductivity, Seebeck coefficient*

References:

1. L. Blanc M. Liu, *Sustainable Materials Technology, **2014**, 9, 26.*
2. B. Poudel, *Science*, **2008**, 4, 634.
3. A. Tavkhelidze, Nanotechnology, **2009**, 20, 405401

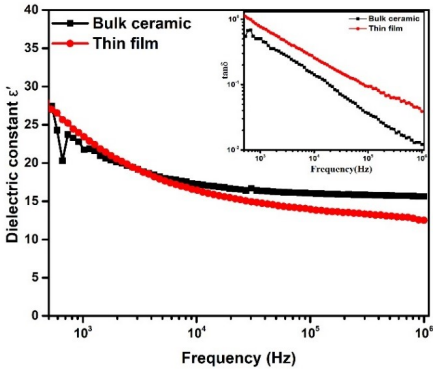
OP-D04

Dielectric characterizations of $BaSnO_3$ bulk ceramics and thin films

S. CHAHIB[1, 2]*, D. FASQUELLE[1] AND G. LEROY[1]
[1]*Univ. Littoral Côte d'Opale, UR 4476, UDSMM, Unité de Dynamique et Structure des Matériaux Moléculaires, F-62228 Calais, France*
[2]*Laboratoire de Matière Condensée et Sciences Interdisciplinaires (LaMCScI), Faculty of Sciences, Mohammed V University, Rabat, Morocco*
***Email:** s.chahib@gmail.com*

$BaSnO_3$-based material is considered as a paraelectric material [1]. It has been used to fabricate thermally stable capacitors [2]. This compound has an excellent thermal stability [3]. The aim of this work is to study the frequency-dependent dielectric properties of bulk ceramics and thin films forms of BaSnO3. For this purpose, the bulk ceramics have been synthesized using the well-known Sol-gel method, while the thin films have been grown using spin-coating technique on $Pt/Ti/Si/SiO_2$ substrate. The XRD diffraction spectra of ceramics and thin films of $BaSnO_3$ showed the cubic perovskite structure. Thin films have been grown with (110) preferred orientation. The SEM showed that grain size for ceramics is ranging from 3.7 µm to 7.2 µm whereas for the surface of thin films is composed of particles with a size between 65 nm and 76 nm. The AFM images showed that the $BaSnO_3$ thin films have a high surface quality. The dielectric properties and AC conductivity of this compound were investigated in the frequency range (20 Hz- 1MHz). The dielectric constant has been found to be around 17 and 13 at 1MHz for the bulk ceramics and thin films, respectively. The tangent loss has been determined to be ~0.0125 and 0.038 at 1MHz for ceramics and thin films, respectively. The present study signifies that the dielectric properties of $BaSnO_3$ ceramic have effectively been transferred to the thin films form, which is essential for technologies that are dedicated to electronics.

Keywords: *$BaSnO_3$, Dielectric properties, AC conductivity, Sol-gel, and Spin-coating.*



References:

[1] A. Aydi, A. Simon, D. Michau, R. Von Der Mühll, N. Abdelmoula, and H. Khemakhem, 'Elaboration and dielectric study of ferroelectric or relaxor ceramics in the ternary system BaTiO3–NaNbO3–BaSnO3', Journal of Alloys and Compounds, vol. 509, no. 29, pp. 7773–7777, Jul. 2011, doi: 10.1016/j.jallcom.2011.04.149.
[2] E. C. Subbarao, 'Ceramic dielectrics for capacitors', Ferroelectrics, vol. 35, no. 1, pp. 143–148, Oct. 1981, doi: 10.1080/00150198108017677.
[3] W.-J. Lee et al., 'Transparent Perovskite Barium Stannate with High Electron Mobility and Thermal Stability', Annu. Rev. Mater. Res., vol. 47, no. 1, pp. 391–423, Jul. 2017, doi: 10.1146/annurev-matsci-070616-124109.

OP-D05

Piezoelectric properties of biobased poly(L-lactide) stretched films for energy harvesting applications

Mohamed Aymen BEN ACHOUR[1,2], Mohamed RGUITI[1], Cédric SAMUEL[2], Georges NASSSAR[3], Sophie BARRAU[4], Birgit STUBBE[5], Marie-France LACRAMPE[2], Cédric SAMUEL[2], Christian COURTOIS[1]

[1]UPHF, EA 2443 - LMCPA, Laboratoire des Matériaux Céramiques et Procédés Associés, F-59313 Valenciennes, France

[2]IMT Lille Douai, Centre d'Innovation, de Recherche et d'Enseignement "Matériaux & Procédés", 941 rue Charles Bourseul, Douai, F-59508, France

[3]UPHF, DOAE, Département Opto-Acousto-Electronique, IEMN-CNRS UMR, F-59313 Valenciennes, France

[4]Univ. Lille, CNRS, INRA, ENSCL, UMR 8207 - UMET - Unité Matériaux et Transformations, F-59000 Lille, France

[5]Centexbel-VKC, Etienne Sabbelaan 49, B-8500 Kortrijk, Belgique

***Email:** *mohamed.benachour@uphf.fr*

This study aims to explore the intrinsic shear piezoelectricity of biobased poly(L-lactide) (PLA) for energy harvesting [1,2]. PLA is a cheap, abundant and non-toxic material [3].

In this work the production of PLA films was carried out by single-screw extrusion, followed by a uniaxial stretching.

Piezoelectric measurements were done to allow quantification of the piezoelectric shear response of PLA films. In addition, the energy harvesting measurement have allowed to compare harvesting power from our different PLA films. Afterwards, an electromechanical model was developed to analyze the effect of different parameters on the electric power.

Consequently, shear piezoelectric properties could be easily developed and optimized for stretched PLA films using conventional processing tools without any electrical poling step. Such biobased materials clearly open new perspectives into cost-effective energy harvesting solutions for low-power electronics.

References:

[1] Shrivanimoghaddam M. et al., IEEE Comm. Surv. Tutor. (2018); arXiv:1712.02277v2
[2] Tajitsu Y., Japanese Journal of Applied Physics (2016), p.04EA07
[3] K. Madhavan et al., Bioresource Technology (2010), p.8493

OP-D06

Morphological characterization of innovative GaN passivation: insights into Normally-off MOS Capacitors

Gauthier LEFEVRE[1,*], Maxime LEGALLAIS[1], Simon MARTIN[2], Sébastien LABAU[1], Franck BASSANI[1], Bernard PÉLISSIER[1], Thierry BARON[1], Laura VAUCHE[2], Cyrille LE ROYER[2], Matthew CHARLES[2], William VANDENDAELE[2], Marc PLISSONNIER[2], Romain GWOZIECKI[2], Bassem SALEM[1,*]

[1] *Univ. Grenoble Alpes, CNRS, CEA/ LETI Minatec, Grenoble INP, LTM, F-38054 Grenoble, France*

[2] *Univ. Grenoble Alpes, CEA, LETI, MINATEC Campus, F-38054 Grenoble, France*

[*] **Emails :** gauthier.lefevre@cea.fr / bassem.salem@cea.fr

Devices based on GaN, particularly high-electron-mobility transistors (HEMTs), are attractive candidates in the renewable energy segment that needs increasing conversion efficiency and power density. The benefits of GaN-based power devices are numerous: fast switching speed, low On-resistance, high breakdown voltage and excellent manufacturing capability. Nevertheless, currently manufacturing normally-off devices remains challenging[1].

In this work, we investigate the interesting solution of High Electron Mobility Transistors with a fully recessed gate Metal-Insulator-Semiconductor structure (MIS-HEMTs) *via* an Al_2O_3/AlN/GaN MOS Capacitor. In particular, the role of substrate biasing during the GaN passivation with AlN deposited by Plasma Enhanced Atomic Layer Deposition (PEALD) was studied[2]. It's well known that environmental conditions during the thin film growth can significantly change the microstructure of the deposited film, and the crystallographic modulation in the film can be directly correlated to the electrical characteristics.

A complete set of physical analyses (pARXPS, DRX, TEM) is presented, to investigate the modifications of the AlN film with respect to deposition conditions. It clearly shows differences in terms of crystal structure, crystallinity, texture and elemental composition, from an epitaxial crystalline layer to an amorphous and rough film. A narrow bias window is found where the GaN passivation is significantly improved compared to a standard AlN film deposited without bias. This leads to a positively shift of the flatband voltage of the C-V characteristics while preserving high AlN/n-GaN interface quality.

Therefore, innovative engineering of the insulator deposition process provides a promising pathway towards the manufacturing of normally-off MOS-channel High Electron Mobility Transistors.

Keywords : *Physical characterization – aluminium nitride - MOSc-HEMTs - PEALD growth*

References:

[1] Amano H, Baines Y, Beam E, Borga M, Bouchet T, Chalker PR et al. The 2018 GaN power electronics roadmap. Journal of Physics D: Applied Physics. 2018 Mar 26;51(16). 163001. https://doi.org/10.1088/1361-6463/aaaf9d

[2] 1. Faraz T, Arts K, Karwal S, Knoops HCM, Kessels WMM. Energetic ions during plasma-enhanced atomic layer deposition and their role in tailoring material properties. Plasma Sources Science and Technology. févr 2019;28(2):024002. https://doi.org/10.1088/1361-6595/aaf2c7

OP-D07

Hybrid thin Films based Phototransistor Optimized by Dynamic Floating Film Transfer Method

TRIPATHI A . S. M.[1*], DUPONCHEL B.[1], BLACH J. F[2]., HOCHEDE F[2]., SAITZEK S.[2], BOUSSOUALEM Y.[1], DAOUDI A.[1]

[1] *Unité de Dynamique et Structure des Matériaux Moléculaires, EA4476.Université du Littoral Côte d'Opale, 59140 Dunkerque, France.*

[2] *Univ. Artois, Centrale Lille, CNRS, Univ. Lille, UMR 8181, Unit. de Catalyse et Chimie du Solide (UCCS), F-62300 Lens, France.*

*** Email:** atul.tripathi@univ-littoral.fr

Organic phototransistor have gained significant research interest owing to their prospective application in society, such as in security, military, health monitoring devices. The number of organic semiconductors including small molecules and conjugated polymers have been used for fabrication of organic phototransistor and reported high responsivity in some materials [1]. From the recent report composite materials by blending the p-type polymers and inorganic nanoparticle have been used for organic phototransistor application due to high charge generation/separation with appropriate driving force such as electron donor – acceptor systems. We have studied poly (3-hexyl thiophene) and ZnO nanorods based composite oriented thin film for phototransistor application after fabricating the OFETs. For this study, first hybrid thin film is prepared by recently developed ribbon-shaped Floating film Transfer Method (FTM) [2]. The hybrid film morphology was investigated by polarized optical microscopy and AFM. Quantitative investigations of film orientation were done by measuring the dichroic ratio (DR). Large area of hybrid thin films up to 20 cm in length and 2 cm in width show a DR= 2 with more than 7 nm redshift wavelength as compared to pristine film. The maximal oriented hybrid films were used as active semiconductor material in the OFETs channel to study their photoresponse properties. The OFETs are characterized under the dark and after the light illumination. Hybrid OFETs show high charge carrier mobility up to μ= 0.009 Cm^2/V s over the pristine. Further, OFETs observed under light illumination (λ=450 nm, P_{in}= 0 to 0.5 mW/cm^2) and show the drain current proportionally increased with Pin due to the photogeneration in addition to the field effect current (figure 1). The amplified drain current indicates improved photosensivity and responsivity.

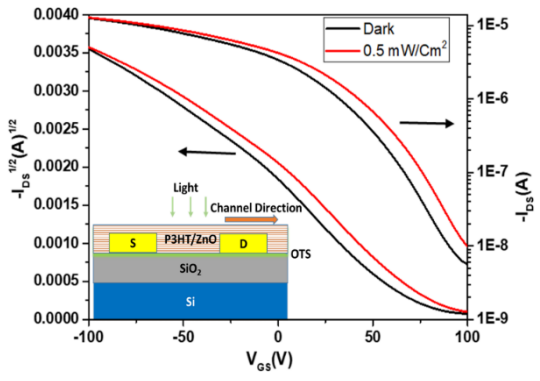


Figure 1. Transfer characteristics of Hybrid phototransistor measured under light illumination from the light intensity 0 to 0.5 mW/cm^2.
t intensity 0 to 0.5 mW/Cm^2

Keywords: *Hybrid phototransistor, P3HT, ZnO nanoparticle, Floating film transfer method.*

References:

1. Kim et al. Chem.commun.47 (2011) 89.

2. Tripathi et al. Appl. phys. lett. 112 (2018) 123301.

Oral Presentations

(Session VA)

OP-VA01

Electronic structure of defected polyethylene for Schottky emission

BUCCELLA G.[1,*], CERESOLI D.[2], VILLA A.[3], BARBIERI L.[3], MALGESINI R.[3]
[1] Departement of Chemistry, Materials and Chemical Engineering "G. Natta", Politecnico di Milano, P.zza L. da Vinci 32-20133, Milan, Italy
[2] Consiglio Nazionale delle Ricerche, Istituto di Scienze e Tecnologie Chimiche (CNR-SCITEC), I-20133 Milan, Italy
[3] Research Energy System - RSE, Via Rubattino 54, Milan, Italy
***Email :** giacomo.buccella@polimi.it

Polyethylene (PE) is one of the most used solid state insulators in electrical power industry. It is especially used to electrically insulate high-voltage cables. Under the stress associated with AC power supplies, this material undergoes ageing, which is often associated with treeing[1]. It is thought that this phenomenon starts from gaseous defects embedded in the insulator bulk, leading to the formation of a cluster of cavities. Treeing is able to dig the matrix until complete breakdown of the insulating components. Cavities are generated by a sequence of partial discharges (PDs). Each PD is triggered by an electron emission from PE into the gas. The Schottky effect (SE) is believed to be the most likely mechanism able to cause this emission[2,3].

Several experiments reproducing treeing propagation or even PDs in isolated voids, using industrial AC power supplies, have revealed that one (or more) discharges take place for each period[4]. This poses a lower bound to SE, since a sufficient number of electrons must be ejected from PE during each oscillation period.

In this work, we have characterized, with density functional theory (DFT) calculations, the electronic structure of several PE surface systems (pure and defected). The goal is to determine under what kind of conditions the expected Schottky energy barrier matches the current lower bound estimated by the experiments cited above.

Our DFT modelling has suggested that SE is highly unlikely to occur if the surface is neutral. Density of states analysis has revealed that the SE is also related to chemical defects. The latter must exhibit electronic states slightly under the conduction band. Furthermore, these sites must be able to act as a trap for negative charge excess. A negatively charged PE system, combined with specific oxidative groups, has proved to be consistent with experimental data.

Keywords : *Electronic structure, Defected Polyethylene, Schottky Effect, DFT simulations*

References

[1] S. Rowland, R. Schurch, M. Pattouras, Q. Li, Application of FEA to imagebased models of electrical trees with uniform conductivity, IEEE Transactions on Dielectrics and Electrical Insulation 22 (3) (2015) 1537-1546.
[2] L. Niemeyer, A generalized approach to partial discharge modeling, IEEE Transactions on Dielectrics and Electrical Insulation 2 (4) (1995) 510-528.
[3] R. Schifani, R. Candela, P. Romano, On PD mechanisms at high temperature in voids included in an epoxy resin, IEEE Transactions on Dielectrics and Electrical Insulation 8 (4) (2001) 589-597.
[4] A. Villa, L. Barbieri, M. Gondola, A. R. Leon-Garzon, R. Malgesini, A PDE-based partial discharge simulator, Journal of Computational Physics 345 (2017) 687-705.

OP-VA02

Thermal and Spectral Dielectric Properties of Polypyrrole/Polymethylmethacrylate Composites

N. ARIBOU[1, *], M. E. ACHOUR[1], L.C. COSTA[2]
[1] *Laboratory of Material Physics and Subatomic, Faculty of Sciences, Ibn Tofail University, BP 242, 14000 Kenitra, Morocco*
[2] *I3N and Physics Department, University of Aveiro, 3810-193 Aveiro, Portugal*
*** Email :** najoia.aribou@uit.ac.ma

Thermal properties of polypyrrole/polymethylmethacrylate (PPy/PMMA) composites were analyzed by thermal gravimetric analysis (TGA) and differential scanning calorimetry (DSC). A decrease in the glass transition temperatures with PPy concentration reveals the increase of segmental motion. The dielectric properties of these composites were studied for several weight concentrations of PPy in the frequency range between 500 Hz and 0.2 MHz, over the temperature range 23–110°C. Jonscher's phenomenological model has been used for modeling the dielectric response of the composite materials. This study shows that the results obtained for the dielectric response are in good agreement with the results of TGA and DSC measurements.

Keyswords: *Thermal properties, Composite materials, Thermal Gravimetric Analysis, Differential Scanning Calorimetry, dielectric properties.*

OP-VA03

Electric modulus spectroscopic studies of the dielectric properties in reduced Graphene Oxide loaded epoxy polymer composites

NIOUA Y.[1,*], MELO B.[2], PREZAS P.[2], GRACA M. F.[2], ACHOUR M.E.[1], COSTA L.C.[2]

[1]Laboratory of Material Physics and Subatomic, Faculty of Sciences, Ibn-Tofail University, BP 242, 14000 Kenitra, Morocco

[2] I3N and Physics Department, University of Aveiro, 3810-193 Aveiro, Portugal

***Email:** yassine.nioua@uit.ac.ma

Dielectric properties of reduced Graphene Oxide (rGO) mixed into epoxy resin, Diglycidyl Ether of Bisphenol A (DGEBA) were studied in the frequency range 10^2 - 10^6 Hz and over the temperature range of 300 - 400 K, using impedance spectroscopy. For this study, a series of samples were prepared with various filler contents. Using the electric modulus formalism, it has been found that these composites exhibit, below and above the percolation threshold ϕ_c a dielectric relaxation phenomenon due to the α- relaxation, which is associated to the glass-rubbery transition of the epoxy matrix above the glass transition temperature. The Cole-Cole model of dielectric relaxation was used for modeling the relaxation processes from which we extract the relaxation parameters. The obtained relaxation parameters suggest a behavior close to single relaxation time. Furthermore, the relaxation time as a function of temperature is characterized by an Arrhenius behavior

Keys words: Composite materials, dielectric properties, relaxation phenomenon, percolation threshold.

OP-VA04

Dielectric Resonator with a Novel Antenna geometry fed by a microstrip line for 5G applications.

Y. EL HASNAOUI[1,*], T. MAZRI[1], M. EL HASNAOUI[2]
[1]*Advanced Systems Engineering Laboratory (ASEL), National School of Applied Sciences, Ibn Tofail University; Kenitra, Morocoo*
[2]*Laboratory of Materials Physics and Subatomic, Faculty of Sciences, Ibn Tofail University. BP 242, 14000, Kenitra, Morocco.*
***Email:** yassine.elhasnaoui@uit.ac.ma,

The present work exhibits a Dielectric Resonator with a Novel Antenna geometry (DRNA) operating at Ka-band for 5th generation (5G) wireless communications. The used dielectric resonator is considered a new candidate in the field of antennas because of its good radiating power factor. The DRNA is made up of a FR4 Epoxy substrate material with relative permittivity of 4.4 and height of 1.8 mm in which we added a dielectric resonator with a relative permittivity of 8.3, height of 1.5 mm and radius of 1.34 mm and fed by a single microstrip line feed. The simulations have been caried out with two Softwares, providing that the antenna is radiating at a frequency of 28 GHz with a return loss value less than 10 dB and good radiation pattern, gain, directivity, and large bandwidth. The obtained results showed that this antenna can be applied in many wireless satellite applications.

Keywords: *Cylindrical Dielectric Resonator Antenna (CDRA), Gain, Return Loss, Directivity, Resonant frequency, 5G.*

OP-VA05

Dielectric spectroscopy of melt-extruded polypropylene carbon nanofiber composites

Z. SAMIR[1,*], A. J. PALEO[2], N. ARIBOU[1], Y. NIOUA[1], M. S. MARTINS[3], M. F. CERQUEIRA[4,5], J. AGOSTINHO MOREIRA[6], M. E. ACHOUR[1]

[1]*Laboratory of Material Physics and Subatomic, Faculty of Sciences, Ibn Tofail University, BP 242, 14000 Kenitra, Morocco*

[2]*2C2T – Centre for Textile Science and Technology, University of Minho, Campus de Azurém, 4800-058 Guimarães, Portugal*

[3]*MEMS – UMinho, University of Minho, Campus of Azurém, Guimarães, 4800-058, Portugal*

[4]*INL – International Iberian Nanotechnology Laboratory, Av. Mestre. Jose Veiga, Braga, Portugal*

[5]*CFUM – Center of Physics of the University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal*

[6]*IFIMUP – Departamento de Física e Astronomia, Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre 687, Porto, 4169-007, Portugal*

***Email :** zineebsamir@gmail.com

The influence of carbon nanofibers (CNFs) weight contents, from 0 to 3 wt. %, on the structural, morphological, and dielectric properties of melt-extruded polypropylene carbon nanofiber composites is discussed in this study. The morphologic analysis reveals that the CNFs exhibited randomly distributed agglomerates in the polypropylene (PP), whereas the structural analysis demonstrates that the CNF degree of disorder was not altered in the PP/CNF composites. The AC conductivity and dielectric permittivity behavior of the PP/CNF composites are discussed and associated with the inter-cluster polarization effects between the CNF agglomerates from the analysis of percolation power laws at a certain weight content of CNFs. Finally, the complex impedance and Nyquist plots of the PP/CNF composites are analyzed by using equivalent circuit models, consisting of a constant phase element. The analysis gathered in here intends to contribute to the dielectric properties understanding of polypropylene composites filled with carbon nanofibers**.**

Keywords: *Polymer composites, Carbon nanofiber, Polypropylene, Dielectric properties, Impedance spectroscopy.*

Acknowledgments: A. J. Paleo acknowledges support from FCT-Foundation for Science and Technology by the "plurianual" 2020-2023 project UIDB/00264/2020, and the TSSiPRO-NORTE-01-0145-FEDER-000015 funded by the regional operational program NORTE 2020, under the PORTUGAL 2020 Partnership Agreement, through the European Regional Development Fund.

OP-VA06

Low temperature synthesis and characterization of barium stannate titanate powders

ZAHID Marwa[a*], AMJOUD M'barek[a], MEZZANE Daoud[a], LAHCINI Mohammed[a] and GOUNE Mohamed[b]

[a]: *IMED-Lab, Cadi Ayyad University, Marrakesh, 40000, Morocco*

[b] : *Institut de Chimie de la Matière Condensée de Bordeaux, University of Bordeaux, Pessac 33600, France*

**Correspondence to: marwaz996@gmail.com*

$BaTi_{0.89}Sn_{0.11}O_3$ is one of the reported systems that exhibits high dielectric properties and enhanced energy storage parameters. In this work, lead free barium stannate titanate was elaborated for the first time via a chimie douce method at low temperature. A pure and uniform ferroelectric powder was obtained at 180°C using sol-gel and hydrothermal combined. The effect of the barium precursor on the purity and the crystallinity of the powderwas also studied. X-ray diffraction (XRD) and scanning electron microscopy (SEM) were used for the characterization of the fine obtained materials. This eco-friendly and pure powder can be used without any further heat-treatment in several applications such as nano-generators for energy harvesting, capacitors and sensors.

Key words: *Lead free BTSn ($BaTi_{0.89}Sn_{0.11}O_3$), sol-gel, hydrothermal, characterization.*

OP-VA07

New two-dimensional functionalized silicon dispersible nanosheets prepared by direct exfoliation of calcium disilicide

ABDALLAH N.[1,*], YOUNESS H.[2], ALI H.[1], SALMA K. H.[1], LAHCEN F.[1], AHMAD M.[3], BURAK D.[4], DAOUD M.[2], EL FIRDOUSSI L.[1], AIT ALI M.[1]

[1]*Laboratoire de Chimie Moléculaire – Unité de Chimie de Coordination et Catalyse, Faculté des Sciences Semlalia, Université Cadi Ayyad, BP 2390, 40001, Marrakech, Maroc*

[2]*Matériaux Innovants Environnement et Développement Durable, Faculté des Sciences et Techniques, Université Cadi Ayyad, BP 2390, 40001, Marrakech, Maroc*

[3] *Institut Charles Gerhardt Montpellier, Université Montpellier, CNRS, ENSCM, Montpellier, France*

[4]*Department of Metallurgical and Materials Engineering, Atatürk University, Erzurum 25240, Turkey*

***Email**: nayad.abdallah@ced.uca.ma

Among the variety of two-dimensional (2D) materials, Silicon Nanosheets (SiNSs) having nanometers thicknesses and lateral dimensions ranging from the submicrometer to the micrometer scale are expected to open new perspectives of applications[1,2] such as energy storage, bio and nanomedicine, biosensors and coating. Since a decade, the functionalization of SiNSs has been explored by difficult multistep reactions with calcium disilicide ($CaSi_2$) as precursor[3]. However, the chemical functionalization of such layered materials suffers some disadvantages and needs to be improved. Herein, we describe a new route involving the direct functionalization of $CaSi_2$ with organic compounds such as benzyl halides and tosyl chloride by heat in a sand bath. The preservation of the crystalline silicon structure was confirmed by X-ray diffraction while the coverage of the organic compounds onto the materials was evident by infrared and thermogravimetric analyses. The morphology of the synthesized nanosheets was investigated by electronic and atomic force microscopy, in which the plate-like structures are seen in several nanometer scales with thicknesses between 2 to 4 nm. Moreover, the dielectric study with temperature dependency showed high dielectric permittivities, without any conducting polymer, induced by different phenomena occurring onto the layered nanosheets. These encourageous results prove that specific applications such as electrochemical detection, antibacterial activities, photovoltaic, photocatalytic and energy storage can be targeted by designing the functionalization onto nanostructured SiNSs.

Keywords: *2D materials; calcium disilicide; exfoliation; functionalization; Dielectric.*

[1] H. Oughaddou, H. Enriquez, M. R. Tchalala, H. Yildirim, A. J. Mayne, A. Bendounan, G. Dujardin, M. Ait Ali, A. Kara, *Prog. Surf. Sci.* **2015**, *90*, 46;

[2] Y. An, Y. Tian, C. Wei, Y. Zhang, S. Xiong, J. Feng, Y. Qian, *Energy Storage Mater.* **2020**, *32*, 115 ;

[3] A. Nayad, S. Kaotar Hnawi, A. Hasnaoui, L. El Firdoussi, M. Ait Ali, *Mater. Today Proc.**2021**, 39, 1103;*

OP-VA08

Investigation of Aloe Vera Latex used as Natural Dye in TiO_2 based Heterojunction and Liquid-Electrolyte Dye Sensitized Solar Cells

Salma Kaotar HNAWI[a,b], Abdelfattah EL MANSOURI[c], Abdelali AGDAD[a], NAYAD Abdellah[b], Mustapha AITALI[b]* and Amane OUERIAGLI[a]

[a] *Laboratory of Materials, Energy and Environment Laboratory (LaMEE), Cadi Ayyad University, Faculty of Sciences Semlalia, Marrakech, Morocco.*

[b] *Molecular Chemistry Laboratory, Coordination Chemistry and Catalysis Unit, Cadi Ayyad University, Faculty of Sciences Semlalia, Marrakech, Morocco.*

[c] *Laboratory of Fluid Mechanics and Energetics, Cadi Ayyad University, Faculty of Sciences Semlalia, Marrakech, Morocco.*

***Email**: aitali@uca.ac.ma

The use of extracted natural compounds as dye sensitizers is a promising option for the fabrication of low-cost solar cells. The latter devices tranform solar energy directly into electricity. In the present study, Aloe Latex Solid (ALS), that is a yellow orange solid compound extracted from the Aloe Vera leaves, was deposited on a TiO_2 thin film (TiO_2/ALS) for the construction of two different configurations of solar cells. The UHPLC-DAD-ESI-MS analysis, UV–Vis and FTIR spectroscopic studies were performed for the prepared dye sensitizer. In fact, the performance of the TiO_2/ALS composite was investigated in a heterojunction dye sensitized solar cell (HJ-DSSC) and a liquid electrolyte-based dye sensitized solar cell (LE-DSSC) to identify the architecture with highest efficiency of sunlight conversion. The obtained results showed encouraging photovoltaic performances with an open circuit voltage (V_{oc}) varying from 0.13 up to 0.30 V, and fill factors (FF) less than 40%. Interesting solar conversion efficiencies were obtained for both architectures with a maximum value of about 1.17% corresponding to the LE-DSSC configuration.

Keywords: *Natural dye, TiO_2, Solar cells, Aloe Vera Latex, Current-Voltage (I-V).*

OP-VA9

From red phosphorus to 2D phosphorene: synthesis and characterization

Faissal EL MANJLI[1,2,*], Omar MOUNKACHI[1,3,4], Abdelilah BENYOUSSEF[5], Abdelfattah MAHMOUD[6], Laura MANCERIU[6], Frédéric BOSCHINI[6] , Khadija EL MAALAM[2], Mohammed HAMEDOUN[4] and Mustapha AIT ALI[1,*]

[1] *Molecular Chemistry Laboratory, Unit Coordination and Catalysis Chemistry, Cadi Ayyad University, Faculty of sciences Semlalia (UCA-FSSM), B.P. 2390 - 40000 Marrakech, Morocco.*
[2] *Moroccan Foundation for Advanced Science, Innovation and Research, MAScIR, Rabat, Morocco.*
[3] *LaMCScI, Faculty of science-Mohammed V University, B.P. 1014, Rabat, Morocco.*
[4] *MSDA, Mohammed VI Polytechnic University, Lot 660, Hay Moulay Rachid Ben Guerir, 43150, Morocco.*
[5] *Hassan II Academy of Science and Technology, Rabat, Morocco.*
[6] *GREEnMat, UR CESAM, University of Liège, Allée du Six Août 13, B-4000 Liège, Belgium.*

***Email :** faissal.elmanjli@ced.uca.ma (Faissal El Manjli)
aitali@uca.ac.ma (Mustapha Ait Ali)

Black phosphorus (BP) is the most promising material among the two-dimensional (2D) materials thanks to its layered structure and excellent semiconducting properties. Currently, bulk BP flakes are synthesized under high pressure and high-temperature conditions by chemical vapor deposition using high-cost Au-catalyst. Consequently, its applications as a crystalline semiconductor material in electronic devices are limited due to the low quality and purity of BP. In this work, we demonstrate an efficient and low-cost synthesis of highly crystalline BP by rapid low-pressure reaction of red phosphorus (RP) in the presence of a small amount of silver (Ag) in a vacuum-sealed quartz tube. The phosphorene layers were prepared by liquid-phase exfoliation (LPE) of high-quality BP crystals using various solvents such as isopropanol (IPA), N-methyl pyrrolidone (NMP) and Dimethylformamide (DMF). The resulting materials are investigated in detail including structural and morphological characterization along with thermal properties. We have obtained BP flakes which are uniform in size and morphology. The lateral sizes of the stable BP range from 50.7 nm after exfoliation in IPA to 204 nm after exfoliation in NMP. The most effective phosphorene layer separation was achieved by using the IPA solvent and centrifugation at 15000 rpm with a monolayer thickness of 0.5 - 0.6 nm. Phosphorene layer thicknesses of 1.0 - 2.0 nm and 1.7 – 2.6 nm are obtained when using NMP and DMF as solvents, respectively. We demonstrate the fine tuning of the optical bandgap by controlling the number of phosphorene layers.

Keywords: *black phosphorus, low-pressure synthesis, liquid phase exfoliation, phosphorene layers, structural and morphological characterization.*

OP-VA10

Giant electrocaloric effect and high energy storage efficiency in lead free BCTSn ceramic elaborated by sol gel method

Y. HADOUCH[1, 2, *] , S. BEN MOUMEN[1], H. MEZZOURH[1, 2], D. MEZZANE[1, 2], M. AMJOUD[1], Y.GAGOU[2], Z. KUTNJAK, M. EL MARSSI[2].

1 Laboratory of Innovative Materials, Energy and Sustainable Development (IMED), Cadi-Ayyad University, Faculty of Sciences and Technology, BP 549, Marrakech, Morocco.
2 Laboratory of Physics of Condensed Matter (LPMC), University of Picardie Jules Verne, Scientific Pole, 33 rue Saint-Leu, 80039 Amiens Cedex 1, France.
3 Jozef Stefan Institute, Jamova Cesta 39, 1000 Ljubljana, Slovenia.
***Email**: : hadouch.younes@gmail.com

The current work deals with the study of structural, dielectric, ferroelectric, energy storage and electrocaloric effect in lead free ceramic BCTSn elaborated by sol gel method. Phase purity structure was confirmed from X-ray data by using Rietveld refinement, and revealing the co-existence of tetragonal (P4mm) and orthorhombic (Amm2) symmetries at room temperature. Phase transitions were pointed out by dielectric and differential scanning calorimetry results. Energy storage properties were determined from P-E hysteresis. Moreover, the electrocaloric effect properties were calculated indirectly via Maxwell approach, and a giant value of ΔT=0.807 K is obtained under 30 kV cm^{-1}. All obtained results make BCTSn ceramics a promising candidate for environmentally friendly refrigeration and energy storage applications.

Keywords : *BCTSn, sol-gel, structural properties, dielectric properties, Electrocaloric, ferroelectricity, Energy storage, phase transition temperature.*

Oral Presentations

(Session VB)

OP-VB01

Effect of an additive organic A1 in improving the quality of nickel electroplating on brass

N. KHEMMOU [a,*], Z. ARIBOU [A], R.A. BELAKHMIMA [b], I. CHAOUKI [b], M.EBN TOUHAMI [a]

[a] *laboratory Advanced Materials and Process Engineering, Ibn Tofaïl University, Kénitra.Morocco*

[b] *University Center for Analysis, Expertise, Technology Transfer and Incubation (CUAETTI), Université Ibn Tofaïl, Kénitra,Morocco*

***Email** : Khemmou2@gmail.com*

Nickel plating on brass is a technique widely used in various industrial activities. The different deposition processes are relatively complex; depend on several factors such as PH, temperature, and bath composition. Nickel plating in watt baths is frequently used in large surface treatment industries due to the appearance and stability of the deposit over time. To improve the quality of nickel deposition on brass, a comparison of nickel plating by the Watts bath with an electrolytic nickel bath mixed with an organic additive, A1 was carried out. Monitoring and characterization of the deposits were carried out by scanning electron microscope (SEM) and X-ray diffraction; the results obtained show the appearance of cracks and micro-grains on the surface of the nickel deposit made in the Watts bath. On the other hand, the proposed bath gives a better quality of the deposit, the addition of the organic adjuvant A1 allows the homogeneity and brightness of the nickel deposit to be maintained.

Keywords: *Brass, Nickel plating, Surface treatment, SEM.*

References:

Nitin P. Wasekar, Prathap Haridoss, S. K. Seshadri, G. Sundararajan Surface and Coatings Technology, Volume 291, 15 April 2016, Pages 130-140

OP-VB02

Synergistic formulation from Allium Sativum essential oil and diethyl thiourea for corrosion inhibition of carbon steel in 0.5 M H_2SO_4 medium.

MZIOUD K.[1,*], HABSAOUI A. [1], LACHHAB R.[1], DKHIRECHE N.[1], GALAI M.[1], EL FARTAH S.[1], EBNTOUHAMI M.[1]

[1]*Laboratory Advanced Materials and Process Engineering, Ibn Tofail University,Kenitra, Morocco*

***E-mail** : khaoula.mzioud@uit.ac.ma*

Carbon steel is one of the most important alloys used in many industries. This type of metal is susceptible to corrosion when in contact with aggressive environmental conditions. Acidic solutions are widely used in industrial acid cleaning, acid descaling and oil well acidification, all of which aggravate steel corrosion. Corrosion inhibition using active substances whose molecular structure admits active adsorption sites with solitary pair and/or π orbitals, such as heterocycles containing sulfur, oxygen, phosphorus, and/or nitrogen atoms, is the least expensive and most effective method of protection. These compounds can form either a strong coordination bond with a metal atom or a passive film on the surface.

Essential oils and plant extracts are extremely rich sources of organic molecules that can act as corrosion inhibitors. This is proven by corrosionists who have started studies on the application of these natural substances.

The objective of our study is to evaluate the synergistic effect of allium sativum essential oil and diethylthiourea to inhibit corrosion of carbon steel against 0.5M sulfuric acid medium, after extraction and identification of the essential oil by gas chromatography-mass spectrometry (GC-MS), an electrochemical study was performed by different electrochemical techniques (impedance spectroscopy (EIS), potentiodynamic polarization, and surface analysis by scanning electron microscopy (SEM)). The polarization curves indicate that the mixture used acts as an excellent inhibitor slowing down the corrosion rate. An appropriate electrical equivalent circuit model was used to calculate the impedance parameters, the results obtained showed that the inhibitory efficiency depends on the concentration of the compound as well as the temperature used. It reached 99% at a concentration of 1.5 g/l, also other thermodynamic parameters of the activation process and metal dissolution as well as SEM results were calculated and discussed.

Keywords: *Corrosion; Carbonsteel; Allium Sativum ; H_2SO_4;Inhibitor.*

OP-VB03

The anti-corrosive property of apatite tricalcium phosphate on carbon steel in two acid media HCl 1M and H_2SO_4 0.5 M.

FERRAA N.[1,*], OUAKKI M.[1,2], CHERKAOUI M. [1,2], BENNANI ZIATNI M.[1]

[1] *Materials, Electrochemistry and Environment team; Organic Chemistry, Catalysis and Environment Laboratory, Faculty of Science, Ibn Tofail University, PB. 133-14050 Kenitra, Morocco.*

[2] *Ecole nationale supérieure de chimie (ENSC), Ibn Tofail University, PB. 133-14050 Kenitra, Morocco.*

***Email:** nouhaila.ferraa@uit.ac.ma

The deterioration of materials under the influence of the surrounding environment causes serious damage up to the destruction of the metal. In order to solve this problem, several protection methods have been considered, among which are corrosion inhibitors.

Apatitic calcium phosphates are biomaterials with attractive physicochemical properties, they have been used for years in the medical field, which makes them a center of interest for researchers to use as corrosion inhibitors of materials. The objective of our study is to evaluate the inhibitory action of apatitic tricalcium phosphate of formula $Ca_9(HPO_4)(PO_4)_5(OH)$ on the corrosion of carbon steel in two aggressive media H_2SO_4 0.5M and HCl 1M. PTCa was synthesized by the double decomposition method in aqueous medium, it was characterized by chemical analysis (CA), Fourier Transform Infrared Spectroscopy(FTIR) and X-ray Diffraction(XRD). Then, it was evaluated as an inhibitor for carbon steel using different electrochemical techniques, electrochemical impedance spectroscopy (EIS) and stationary polarizations (PDP). Thus, an analysis of aggressive solution before and after addition of PTCa was carried out by visible UV.The results obtained show that the inhibitory efficiency of PTCa in 1M HCl reaches 93% at a concentration of 50 ppm and 95% at a concentration of 200 ppm in 0.5M H_2SO_4.

Keywords*: carbon steel, Apatitic tricalcium phosphate, inhibitor, acid media, Corrosion.*

OP-VB04

Molecular simulations of dielectric and spectroscopic properties of 4-Cyano-4'-pentylbiphenyl liquid crystal and their comparison with experimental findings

Bhavna PAL[1], Sumit TIWARI[1], Devendra SINGH[1], Asmita SHAH[2], Michael DEPRIESTER[3], Dharmendra Pratap SINGH[2]

[1] *Department of Physics, School of Physical and Decision Science, Babasaheb Bhimrao Ambedkar University Raibareli road, Lucknow*,226002-India

[2] *Université du Littoral Côte d'Opale, UR 4476, UDSMM, Unité de Dynamique et Structure des Matériaux Moléculaires, F-62228 Calais, France*

[3]*Université du Littoral Côte d'Opale, UR 4476, UDSMM, Unité de Dynamique et Structure des Matériaux Moléculaires, 145, Av Maurice Schumann 59140 Dunkerque, France*

***Email:** bhavnapal62@yahoo.com

The liquid crystalline materials exhibit a certain degree of orientational and positional order parameters along with the fluidity due to the presence of alkyl chain in the structure. This combination of parameters makes them suitable that lead to a plenty of fundamental and technical applications. In this investigation, the structural, dielectric and other physical properties of a well-known liquid crystal (LC) material namely 4-Cyano- 4'-pentylbiphenyl (5CB) have been theoretically investigated via density functional theory (DFT) by using the Gaussian 09 and Quantum ESPRESSO tools and a comparison has been done with the experimental findings. The dielectric properties were successfully simulated in THz region using DFT theory along with experimental investigation in the 100 Hz- 1 MHz region. The dielectric results have been found to be in good agreement with the previous findings. This study certainly provides further insight to investigate anisotropic material theoretically as well as experimentally in order to use it for low and high-frequency applications.

Keywords: *Density functional theory, 5CB liquid crystal*

Oral Presentations

(Session VC)

OP-VC01

AC conductivity and dielectric response of carbon dots/PMMA nanocomposite materials

BOUKNAITIR I.[1, *], TEIXEIRA S.S.[2], A. PANNIELLO A.[3], STRICCOLI M. [3], COSTA L.C.[2], M. E. ACHOUR M.E. [1]

[1]Laboratory of Material Physics and Subatomic, Faculty of Sciences, Ibn-Tofail University, BP 242, 14000 Kenitra, Morocco

[2] *I3N and Physics Department, University of Aveiro, 3810-193 Aveiro, Portugal*

[3]*CNR-IPCF-Bari Division, c/o Chemistry Department, University of Bari, Via Orabona 4, 70126, Bari, Italy*

***Email :** ilham.bouknaitir@gmail.com

The AC electrical conductivity and dielectric properties of an original nanocomposite based on the incorporation of carbon dots (C-dots) in poly (methyl methacrylate) (PMMA) at several filler loadings were studied in the frequency range from 100 Hz to 100 kHz, in the temperature range from 200 to 380 K.We provide experimental evidence that at low frequencies the dielectric response without peak loss ε''_{max} is anomalous low-frequency dispersion. Also, below percolation threshold [1], and at high frequencies, the curves of ε' and ε'' are parallel, suggesting that the presence of the fillers greatly affect the dielectric properties of the polymer matrix because of polarization phenomenon induced by the C-dots nanoparticles. This theoretical framework is consistent with several aspects of the experiments, notably the power-law decays of the real and imaginary parts of the complex permittivity which is characterized by the fractional exponents' *n*. The obtained exponents are positive and smaller than unity, with a value close to 1. These values of *n* are decreasing with increasing of the temperature and filler loading. We found that the activation energy is insensitive to the presence of the C-dots nanoparticles, thus revealing the weak interaction between the nanofillers and the chain segments of the macromolecules in the copolymer [2].

Keywords : *AC conductivity, Dielectric response, C. dots, nanocomposites*

References:

[1]. Z. El Ansary, I. Bouknaitir, S. S. Teixeira, L. Kreit, A. Panniello, M. Striccoli, M. El Hasnaoui, L.C. Costa, M. E. Achour, « Electrical properties in pmma/carbon-dots nanocomposite films below the percolation threshold » NATO Science for Peace and Security Series B: Physics and Biophysics by Springer, pp. 235–250, 2020.

[2]. I. Bouknaitir, S. S. Teixeira, L. Kreit, A. Panniello, P. Fini, M. Striccoli, L. C. Costa, M. E. Achour, « Thermal and dielectric properties of nanocomposites based on carbon dots », Journal de Polymer Composites, 2019, ID PC-18-1982.R1.

OP-VC02

Effects of Additive in an Electrodeposition Bath on the Surface Morphologic Evolution of Electrodeposited Copper

ARIBOU Z. [1, *], **KHEMMOU N.**[1], **BELAKHMIMA R.A.** [1], **CHAOUKI I.** [2], **EBN TOUHAMI M** [1]

[1] *Laboratory Advanced Materials and Process Engineering, Ibn Tofail University, Kenitra, Morocco*

[2] *Centre Universitaire d'Analyses, d'Expertise, de Transfert de Technologies et d'Incubateur (CUAE2TI), Université Ibn Tofaïl, Kénitra, Morocco*

***Email:** zakia.aribou@uit.ac.ma

In this work, copper electroplating has been frequently used to improve the quality of copper deposition (brightness, hardness, adhesion...). The effect of an organic additive AN under various concentrations on electrodeposited copper was studied. Correctly concentrations of the organic additive AN added in the electrodeposition bath made the adsorbed additive partly converge and optimized the quality of the copper plating. In addition, the morphology of the copper deposits obtained in the absence and presence of organic compounds has been studied by scanning electron microscopy (SEM). An improvement of the roughness degree and crystallite size upon the addition of AN has been found. The best results were obtained for AN working at room temperature (25 ± 0.1°C) and 1 Adm^{-2} current density.

Keywords: *Copper; Electroplating; Cyclic voltammetry; Current density; SEM.*

OP-VC03

Electrical, and dielectric properties of Yttrium-doped $BaTiO_3$ ceramics.

Zineb GARGAR[1], Abdelouahad ZEGZOUTI[1], Mohamed ELAATMANI[1], Amina TACHAFINE[2], Didier FASQUELLE[2], Abdelkader OUTZOURHIT[3], Mohamed DAOUD[1] and Mohamed AFQIR[1]

[1] Laboratoire des Sciences des Matériaux et Optimisation des Procédés, Faculté des Sciences Semlalia, Université Cadi Ayyad, Marrakech, Morocco

[2] Unité de Dynamique et de Structure des Matériaux Moléculaires (UDSMM), Maison de la Recherche Blaise Pascal, Université du Littoral Côte d'Opale, 50 rue Ferdinand Buisson, B.P. 717, 62228 Calais, France. Calais, France

[3]Laboratoire de nanomatériaux pour l'énergie et l'environnement, Faculté des Sciences Semlalia, Université Cadi Ayyad, Marrakech, Morocco

***Email :** zineb.gargar@ced.uca.ma

The main purpose of the present work is to investigate the dielectric properties of BT and $Ba_{0.98}Y_{0.02}Ti_{0.995}O_3$ ceramic prepared via solid-state reaction under a sintering temperature of 1250 °C which is the lowest temperature as compared to the literature. To our understanding, there is a scarcity of information on $Ba_{0.98}Y_{0.02}Ti_{0.995}O_3$ electrical and dielectric studies. For these reasons, phase structure characterization, scanning electron microscopy, FTIR, and Raman spectroscopy were investigated. Then, the dielectric was evaluated using the temperature dependence of the dielectric permittivity and loss tangent (tanδ). Also, the conductivity of ceramics was discussed by applying the Arrhenius equation. The frequency dependence of impedance and electric modulus properties were studied over a wide frequency range at various temperatures. The tetragonality of these structures was identified by using powder X-ray diffraction and Raman analysis. Structurally, $BaTiO_3$ has a uniform gain size, but $Ba_{0.98}Y_{0.02}Ti_{0.995}O_3$ sample consists of a different shape and size with homogeneous morphology and dense microstructure, as observed by scanning electron microscopy. Through dielectric measurements, the Y-doped BT ceramic had a higher Curie temperature (T_C) and dielectric constant at T_C (125°C and 6071) compared to the pure $BaTiO_3$ ceramic (110°C and 4156) when measured at 100 kHz [1], [2]. The modeling dielectric constant confirmed the presence of first-order and displacive transitions for both samples, but the diffusive behavior took place in the doped sample. It was also confirmed, regarding conductivity, that introducing Yttrium into the $BaTiO_3$ structure is a viable way to reduce the number of oxygen vacancies. Furthermore, Complex impedance Cole-Cole showed the relaxation behavior in the $Ba_{0.98}Y_{0.02}Ti_{0.995}O_3$ materials to be of non-Debye type.

These works motivate to produce a dense $Ba_{0.98}Y_{0.02}Ti_{0.995}O_3$ ceramic with fewer defects, and a low concentration of oxygen vacancies.

Keywords: *Perovskite, Structural, Dielectric, Conductivity, Impedance spectroscopy*

References:

[1] F. A. Ismail, R. A. M. Osman, M. S. Idris, S. Taking, and Z. A. Z. Jamal, "Dielectric and microstructural properties of BaTiO3 and Ba0.9925Er0.0075TiO3 ceramics," *EPJ Web Conf.*, pp. 5–9, 2017.

[2] C. A. Vasilescu, L. P. Curecheriu, L. Mitoşeriu, And A. C. Ianculescu, "Phase Formation , Microstructure And Functional Properties Of Some Bati 1-X Zr X O 3 Ceramics," *U.P.B. Sci. Bull., Ser. B*, Vol. 77, No. 1, 2015.

OP-VC04

The improvement of mechanical properties of lead acid battery grids

S. SAISSI*[1], E. SAAD[1], O. BENLENDA[1], Y.AIT YASSINE[2]
1: Laboratory of Physicochemistry of Materials and Processes, Hassan 1 University, Settat Morocco
2: Laboratory of Thermodynamics and energy, Ibn Zohr University, 80000 Agadir, Morocco.
***Email :** saissisoukaina90@gmail.com*

Research works on lead alloys are experiencing an increasing growth both for the fundamental study of their structural properties and for their numerous applications in the automotive industry. Indeed, for ecological and economic reasons, much research has been carried out in order to increase the performance of the lead-acid battery for its use as an energy source in electric cars. The challenge is therefore to select an alloy with good corrosion resistance and improved mechanical properties. The use of lead alone is excluded because this metal is soft and malleable, thus lacking hardness and strength. But the dissolution of a few solutes in the liquid lead solvent allows the supersaturation of the primary solid phase and thus makes it possible to obtain cured alloys for the manufacture of plate's accumulator [1, 2]. Our aim is to select lead alloys with a good corrosion resistance and improved mechanical properties based on aging and over aging process of supersaturated quenched solutions. Indeed, two structural states are considered: as-cast alloy and rehomogenized. The influence of temperature has been studied. The techniques used are: hardness, micro-hardness, optical microscope, X-ray diffraction and scanning electron microscope.

Keywords: *Alloy, battery grids, Lead, hardness, aging.*

References:

[1] E.Hilali, state thesis,"Etude des mécanismes de durcissement structural des alliages Pb-Cd,Pb-Cd-Sn Pb-Cd-Ag, pour grilles de batteries". Ibn Zohr university, Agadir (1999).

[2] L. Bouirden, Thèse de doctorat de 3ème cycle, Nancy, 1990.

OP-VC05

The mechanism study of the breakdown process of air near the flashover discharge

M. HAMOUDA,[A]

[a] *Laboratoire de développement durable et d'informatique, Université Ahmed Draia, Adrar, Algeria.*

***Email :** jhamouda@yahoo.fr

The phenomenon of flashover observed on the insulators of the airlines of the high voltage polluted is the result of a process, which proceeds in successive stages well defined. The origin of this phenomenon is related to the covering of the surface of the insulators of a layer of conducting pollution. This layer is not deposited in a uniform way, its distribution along the creepage distance present of fluctuating dimensions. The majority of the equipment of the high voltage are installed in the open air in atmospheres aggressive and polluted such as the zones tropical, Arctic, littoral. Each one of these areas is characterized by a climate and a specific pollution. For this reason, the pollution of the insulators associated with the presence with moisture decreases the level of insulation of the system. Indeed the contribution of water on the level of the deposit of pollution causes the dissolution of salts and conduit to the formation of an electrolytic layer. A leakage current, circulates then in the surface layer by causing a local draining of the electrolyte, which causes to increase the conductivity of the medium. Surface discharges appear on surface, which under favorable conditions lengthen along the insulator and connect the high voltage to the mass, this phenomenon is called flashover [1-3]. This work concerns the study of the electric vicinity of the air under the influence of certain parameters: resistivity, polarity, initial current of the discharge as well as the electric field. We made an experimental study on the rupture of the air in an interval between a discharge and an electrolytic surface of which the goal to clear up the mechanism of evolution of the discharge of skirting. The experimental results of this handling are exceptional from the point of view influences local discharge (trigger) on the effect of the polarity of the breaking stress of the principal interval [4-6].

***Keywords**: Discharge, Flashover, Insulator, Pollution, High voltage*

References:

1- F.Obenaus "Die uberschlagspannung verschmutzter isolatoren'' ETZ, vol.56, 1935, p.p. 369-70.
2- J.C. Labadi "Etude de la validité du modèle électrique du contournement des isolateurs haute tension pollués" Thèse de spécialité. Université Paul Sabatier Toulouse. 1971
3- H.Matsuo, T. Yamashita and W.D. Shi, "Electrical contact between a local discharge on an electrolyte solution and the solution surface, IEEE Trans. On Dielectric and Elect. Insul., Vol. 7, pp. 360-365, 2000.
4- S.Flazi, H.Hadi, K.L.Rabah, M.Hamouda, A.Boudjella "Dynamic aspect of the direct current flashover on rectangular and new disk models". I.E.E.E/ CEIDP'2001, Kitchener, On, Canada, oct.14-17,2001.
5- S. Flazi, M. Hamouda "Influence of the electric field to the neighborhood of the discharge on its propagation to flashover" ELECO'99, Turkey.
6- Slama, M. E. A., & Beroual, A. (2015). Behavior of AC High voltage polyamide insulators: Evolution of leakage current in different surface conditions. Advances in Electrical and Electronic Engineering, 13(2), 74.

OP-VC06

Composite multiferroics with phosphate ceramic as a matrix.

A. PLYUSHCH[1,2,*], N. MACIULIS[1], A. SOKAL[3], R. GRIGALAITIS[1], J. MACUTKEVIC[1], A. KUDLASH[3], K. LAPKO[3], A. SELSKIS[4], D ADAMCHUK[5], V. KSENEVICH[5] P. KUZHIR[6,2], J. BANYS[1]

[1] Vilnius University, Vilnius, Lithuania
2 Institute for Nuclear Problems, Minsk, Belarus
3 Faculty of Chemistry, Belarusian State University, Minsk, Belarus
4 Center for Physical Sciences and Technology, Vilnius, Lithuania
5 Faculty of Physics, Belarusian State University, Minsk, Belarus
6 University of Eastern Finland, Joensuu, Finland
***Email :** artyom.plyushch@ff.vu.lt

The phosphate bonded ceramics (PBCs) is the intermediate step between the inorganic and polymer materials. An important advantage of PBCs is the simplicity and low cost of the preparation procedure, phosphates are safe and eco-friendly. The preparation and curing steps are possible at room temperature or with slight heating, no sintering is required. The absence of the sintering step allows to load the samples with additional fillers and avoid interactions between them, such as reactions between ferroelectrics and ferromagnetic phases in composite multiferroics or evaporation of lead from lead-based ferroelectrics.

Here we report on the study of the composite materials based on the phosphate matrices with ferroelectric inclusions ($Pb(Mn_{1/3}Nb_{2/3})O_3 - PbTiO_3$) and a mixture of ferroelectrics ($BaTiO_3$) and ferromagnetics (Fe_3O_4). Several significant advantages of the utilization of phosphates were found. In comparison with the polymer-based or cement-based composites, the usage of phosphate matrices allows to successfully synthesize of composite material with substantially high (83 wt. %) content of ferroelectrics. In contrast to the presented in literature methods of the multiferroic material synthesis, the phosphate-based ceramics benefits the simplicity of the preparation. In comparison with polymer-based composites, the inorganic matrix provides advanced thermal stability and mechanical contacts between different phases.

The dielectric, ferroelectric, magnetic and piezoelectric properties of the prepared samples were studied in wide temperature ranges. The dependence of the density of the ceramic on the applied pressure was investigated. The XRD analysis indicates the absence of any side-products obtained upon the synthesis procedure. The characteristics of the composites are stable in the temperature range up to 900 K.

The presented methods of the preparation of the matrix-based composites filled with ferroelectric, ferromagnetic particles and their mixture are promising for the variety of applications. In particular, the composites with ferroelectric nanoparticles are perspective for the memory devices, electromechanical sensors and energy storage. The composites with ferromagnetic particles applied for electromagnetic shielding, construction materials and anti-corrosion coatings. The multiferroic composites are perspective for the range of sensing, transduction and memory applications.

Keywords : *Barium titanate, PMN-PT, Magnetite, Phosphates, Multiferroic, Composite.*

Acknowledgements: A.P. is supported by the European Social Fund under the No 09.3.3-LMT-K-
712-19-0146 "Development of Competences of Scientists, other Researchers and Students through Practical Research Activities".

OP-VC07

Dielectric relaxation in $Ba(Ti_{1-x}Sn_x)O_3$ solid solutions

SVIRSKAS Š.[1,*], ŠLINKŠYTĖ E.[1], KLIMAVIČIUS V.[1], ADAMCHUK D.[1], BIRKS E.[2], KAMBA S.[3], ŠABLINSKAS V.[1], BALEVIČIUS V.[1], BANYS J.[1]

[1] *Vilnius University, Faculty of Physics, Saulėtekio al. 3, LT-10257 Vilnius, Lithuania*
[2] *Institute of Solid State Physics, University of Latvia, Kengaraga 8, LV-1063, Riga, Latvia*
[3] *Institute of Physics, Czech Academy of Sciences, Na Slovance 2, 182 21 Prague 8, Czech Republic*

***Email :** sarunas.svirskas@ff.vu.lt

Barium titanate (BTO) is a first inorganic material where the ferroelectricity was discovered. Barium titanate has a perovksite structure in which ferroelectricity occurs due to the off-centering of Ti ions in oxygen octahedral cage. The material undergoes three consecutive phase transitions [1]. The high temperature phase is paraelectric which transforms to the tetragonal, orthorhombic and rhombohedral ferroelectric phases when the temperature decreases.

Barium titanate can be considered as multifunctional materials for different applications. The largest application area of BTO is multilayered ceramic capacitors due to its large weakly temperature dependant permittivity in the vicinity of room temperature. Unfortunately, the loss and energy storage density of such capacitors are strongly dependent on the domain structure of the ferroelectric phase of BTO. In order to maximize the energy storage density and decrease the loss which arises due to domain wall motion, it is necessary to modify BTO to pin the domains or reduce their density.

Isovalent substitutions such as Ce^{4+}, Zr^{4+}, Hf^{4+} or Sn^{4+} instead of titanium ion modifies the phase transitions of barium titanate. Some of these ions can be substituted throughout all the concentration range. The material undergoes crossover from ferroelectric properties to a relaxor properties.

In this contribution we will focus on the Sn^{4+} substituted barium titanate ($BaTi_{1-x}Sn_xO_3$) in the crossover region (i. e. $0.15 \leq x \leq 0.3$) between ferroelectric and relaxor behavior. The dynamics of the crossover will be studies by broadband dielectric spectroscopy methods from milihertz to terahertz range. Also, the NMR studies of tin ions will be presented. Such experimental technique will provide some insights about different displacements of a titanium ions surrounding tin.

Keywords: *relaxors, perovskite oxides, barium titanate, broadband dielectric spectroscopy*

Acknowledgement

This project has received funding from European Social Fund (project No 09.3.3-LMT-K-712-19-0052) under grant agreement with the Research Council of Lithuania (LMTLT).

References

[1] P. W. Forsbergh, Domain Structures and Phase Transitions in Barium Titanate, Phys. Rev. 76, 1187 (1949).

OP-VC08

Dielectric properties of new lead-free oxide materials ceramics on the base of KNN and NBT perovskites

POLITOVA E.[1], KALEVA G.[1], MOSUNOV A.[2], STEFANOVICH S.[2] SHAVARTSMAN V.[3]

[1]*Semenov Federal Research Center for Chemical Physics, Russian Academy of Sciences, Kosygina str., 4, Moscow, 119991 Russia*

[2]*Moscow State University, Moscow, Leninskie Gory, 1, 119991 Russia*

[3]*Institute for Materials Science Duisburg-Essen, University of Duisburg-Essen, Universitatsstrasse 15, 45141 Essen, Germany*

Email : politova@nifhi.ru

Lead-free perovskite oxides based on ferroelectrics $(K_{0.5}Na_{0.5})NbO_3$ (KNN), $BaTiO_3$ (BT), and ferroelectric-relaxor $(Na_{0.5}Bi_{0.5})TiO_3$ (NBT) are being intensively studied in order to replace widely used toxic Pb-based ones. These oxides are promising for applications in capacitors, piezoelectrics, electrocaloric and other devices. We studied influence of donor and acceptor dopants on structure, microstructure, and dielectric properties of compositions from Morphotropic Phase Boundary (MPB) in the KNN-BT and NBT-BT systems additionally modified with overstoichiometric additives KCl, NaCl, LiF, ZnO и CuO. Ceramic samples were prepared by the two-step solid-state reaction method and were characterized using complex of physico-chemical methods: X-ray Diffraction, Scanning Electron Microscopy, Second Harmonic Generation, and Dielectric Spectroscopy. Unit cell parameters changes were observed in modified compositions depending on radii of substituting cations. Ferroelectric phase transitions at 400 – 700 K were observed. Phase transitions near ~ 400 K in NBT-based compositions revealed typical relaxor behavior related to the presence of polar nanoregions in a nonpolar matrix. Additionally, effects of dielectric relaxation caused by formation of oxygen vacancies due to possible defficiency in the A-sites and/or by the presence of cations with mixed valency in the B-sites of perovskite lattice were observed at temperatures > 700 K. The compositions characterized by increased values of dielectric permittivity at the room temperature and spontaneous polarization were revealed confirming prospect of their functional properties improvement.

Keywords*: Perovskite structure, Dielectric materials, Ferroelectrics.*

Funding: The work was supported by the RFBR and DFG (Project 21-53-12005).

Biography :

Ekaterina D. Politova finished Physical faculty of the M.V. Lomonosov Moscow State University and received her PhD and Habiliate (Doctor of Science in Physics and Mathematics) degrees and Professor title in the L.Ya. Karpov Institute of Physical Chemistry, Moscow, Russia. Now she is Leading Researcher in N.N. Semenov Federal Research Center for Chemical Physics, Russian Academy of Sciences, Moscow She published more than 150 papers in scientific journals.

Poster Presentations

(Session VA)

PP-VA01

Synthesis, structure, dielectric, and energy storage properties of $Ba_{0.85}Ca_{0.15}Zr_{0.1}Ti_{0.9}O_3$ ceramics under large electric field

A. LAKOUADER[1*], H. MEZZOURH[1,2], D. MEZZANE[1,2], M. AMJOUD[1], L. HAJJI[1], E. CHOUKRI[1], I.A. LUK'YANCHUK[2,3].

[1] *Laboratory of Innovative Materials, Energy and Sustainable Development (IMED), Cadi Ayyad University, Faculty of Sciences and Technology, BP 549, Marrakech, Morocco.*

[2] *Laboratory of Physics of Condensed Matter (LPMC), University of Picardie Jules Verne, Scientific Pole, 33 rue Saint-Leu, 80039 Amiens Cedex 1, France.*

[3] *Physics Faculty, Southern Federal University, Rostov-on-Don, 344090, Russia*

***Email:** afaak.lakouader@gmail.com, afaak.lakouader@ced.uca.ma

Lead-free $Ba_{0.85}Ca_{0.15}Zr_{0.1}Ti_{0.9}O_3$ (referred to as BCZT) ceramic powders were synthesized using the sol-gel method. Dielectric, ferroelectric, and energy storage properties were investigated. Indeed, pure crystalline structure and homogenous microstructure are identified by XRD analysis and SEM measurement.

The dielectric measurements in a frequency range of [100Hz-1MHz] and a temperature range [20-200°C] reveal a maximum dielectric constant which is associated with ferroelectric-paraelectric phase transition[1]. The dielectric constant ε_r at 1kHz was 18177 around 78°C which indicates that the sol-gel method has displayed important electrical properties.

The P-E loop shows a closed and saturated loop similar to a conventional ferroelectric [2]. The maximal polarization (P_{max}), the remnant polarization (P_r), the charge storage density ($Q_c = P_{max} - P_r$) and the coercive field (Ec) were found to be 25,59 µC/cm², 15,19 µC/cm², 10,4 µC/cm², and 6 kV/cm, respectively. Besides, BCZT showed better recoverable energy density W_{rec} of 0.23 J/cm3 with an efficiency coefficient of ~ 88% at 150 °C under an electric field of 55 kV/cm. These results suggest that the synthesized BCZT ceramic could be a promising candidate for energy storage applications [3].

Keywords: *BCZT ceramics; sol-gel method; dielectric; energy storage.*

References

[1] J. P. B. Silva *et al.*, « Ferroelectric phase transitions studies in 0.5Ba(Zr0.2Ti0.8)O3-0.5(Ba0.7Ca0.3)TiO3 ceramics », *J. Electroceramics*, vol. 35, n° 1, p. 135-140,(déc. 2015).

[2] H. Mezzourh *et al.*, « Enhancing the dielectric, electrocaloric and energy storage properties of lead-free Ba0.85Ca0.15Zr0.1Ti0.9O3 ceramics prepared via sol-gel process », *Phys. B Condens. Matter*, vol. 603, p. 412760, (févr. 2021).

[3] S. Merselmiz *et al.*, « High energy storage efficiency and large electrocaloric effect in lead-free BaTi0.89Sn0.11O3 ceramic », *Ceram. Int.*, vol. 46, n° 15, p. 23867-23876, (Oct. 2020).

PP-VA02

Preparation and characterization of $Cu_2Fe_{1-x}Co_xSnS_4$ thin films via sol-gel method

S.DRISSI [1,*], A. EL KISSANI[1], A.ABALI[1], D.AIT LHAJ[1, 2], L. NKAILI[1]K. EL ASSALI[1], A. OUTZOURHIT[1]

[1]*Materials, Energy and Environment Laboratory, Faculty of Sciences Semlalia, Cadi Ayyad University, PB 2390, Marrakech, Morocco*

[2] *Materials and Energy Laboratory, Polydisciplinary Faculty of Ouarzazate, Ibn Zohr University, Morocco*

[*] **Email:** Drissi.safia@gmail.com

The compound copper iron cobalt tin sulfide $Cu_2Fe_{1-x}Co_xSnS_4$ (CFCTS) is a potential absorber thin film candidate for solar cells. In the present work, CFCTS thin film with x = 75% was deposited on soda lime glass substrates,using sol-gel spin coating technique without a sulfurization step. X-ray diffraction, Raman spectroscopy, scanning electron microscopy, energy dispersive analysis and UV-Vis-NIR spectrometry were used to investigate the effect of annealing temperature ranging from 200 °C to 400°C in a nitrogen atmosphere for 1 hour on the structural, morphological, compositional and optical properties of the deposited thin films. The optimal annealing temperature of the pure, uniform, dense and stoichiometric CFCTS thin film is found to be 300°C. In addition, UV-Vis analysis confirms the optical band gap of 1.32 eV in the visible region which is the optimal value for converting amount of energy from solar spectrum into electricity.

Keywords: *$Cu_2Fe_{1-x}Co_xSnS_4$, Sol-gel, annealing, Structural, Morphological, Electrical, Optical properties.*

PP-VA03

A comparative study of structural, electrical, and energy storage properties in lead-free BCZT ceramics: Influence of the reduced thickness of ceramics.

A. LAKOUADER[1*],D. MEZZANE[1,2], M. AMJOUD[1], L. HAJJI[1], E. CHOUKRI[1], I.A. LUK'YANCHUK[2,3].

[1] *Laboratory of Innovative Materials, Energy and Sustainable Development (IMED), CadiAyyad University, Faculty of Sciences and Technology, BP 549, Marrakech, Morocco.*
[2] *Laboratory of Physics of Condensed Matter (LPMC), University of Picardie Jules Verne, Scientific Pole, 33 rue Saint-Leu, 80039 Amiens Cedex 1, France.*
[3] *Physics Faculty, Southern Federal University, Rostov-on-Don, 344090, Russia*

[*]**Email :** afaak.lakouader@gmail.com, afaak.lakouader@ced.uca.ma

Lead-free $Ba_{0.85}Ca_{0.15}Zr_{0.1}Ti_{0.9}O_3$ (referred to as BCZT) ceramic powders were synthesized using the sol-gel method. Dielectric, ferroelectric, and energy storage properties were investigated. In order to apply strong electric fields, the thickness of ceramics was reduced by polishing. The BCZT ceramic with 0.4 mm shows improved proprieties. Indeed, pure crystalline structure and homogenous microstructure are identified by XRD analysis and SEM measurement. The P-E loop shows a closed and saturated loop similar to a conventional ferroelectric [1]. The maximal polarization (Pmax), the remnant polarization (Pr), the charge storage density (Qc = Pmax - Pr) and the coercive field (Ec) were found to be 25,59 µC/cm², 15,19 µC/cm², 10,4 µC/cm², and 6 kV/cm, respectively. Besides, BCZT showed better recoverable energy density Wrec of 0.23 J/cm^3 with an efficiency coefficient of ~ 88% at 423K under an electric field of 55 kV/cm. These results suggest that the synthesized BCZT ceramic could be a promising candidate for energy storage applications [2].

Keywords *: BCZT ceramics; sol-gel method; dielectric; energy storage*

References :

[1] H. Mezzourh et al., « Enhancing the dielectric, electrocaloric and energy storage properties of lead-free Ba0.85Ca0.15Zr0.1Ti0.9O3 ceramics prepared via sol-gel process », Phys. B Condens. Matter, vol. 603, p. 412760, (févr. 2021).
[2] S. Merselmiz et al., « High energy storage efficiency and large electrocaloric effect in lead-free BaTi0.89Sn0.11O3 ceramic », Ceram. Int., vol. 46, no 15, p. 23867-23876, (Oct. 2020).

PP-VA04

Lead titanate ferroelectric thin films prepared by polymeric precursor method

M. EL HASNAOUI[1,*], O. AZAROUAL[1,2], B. AKHARCHACH[2], A. NARJIS[3]

[1]*Laboratory of Material Physics and Subatomic, Faculty of Sciences, Ibn-Tofail University, BP 242, 14000 Kenitra, Morocco*

[2]*Laboratoire de Physique Théorique et Appliquée, Faculté des Sciences Dhar Mehrez, BP 1796, Fès-Atlas, Morocco*

[3]*Nanomaterials for Energy and Environment Laboratory, Physics Department, Faculty of Sciences Semlalia, Cadi Ayyad University, PO Box 2390, Marrakech 40000, Morocco*

*Email: med.elhasnaoui@uit.ac.ma

The structural characterization and ferroelectric properties of lead titanate ($PbTiO_3$) thin films successfully deposited on SiO_2/Si(100) and $LaNiO_3$(110)/SiO_2/Si(100) substrates using the sol-gel spin coating process have been studied. XRD patterns showed that the thin films have the perovskite phase. The ferroelectric character was confirmed by the P-V loops that recorded on this film with a remanent polarization and coercive field in the order to those reported for other similar systems, the measured current-voltage characteristics were found to be space charge conduction in the high applied voltage and its piezoelectric coefficient d_{33} was measured by a Laser Scanning Doppler Vibrometer.

Keywords: *Lead titanate thin film, Structural characterization, Ferroelectric properties*

PP-VA05

Investigation of dielectric properties of water dispersion of reduced graphene oxide/water nanofluid composite

N. ARIBOU[1,] *, Z. SAMIR[1], S. BOUKHEIR [2], R. BELHIMRIA[1], M. E. ACHOUR[1] , N. ÉBER[3], L. C. COSTA[4], A. OUERIAGLI[5]

[1] *Laboratory of Material Physics and Subatomic, Faculty of Sciences, Ibn Tofail University, BP 242, 14000 Kenitra, Morocco*

[2] *Moroccan Foundation for Advanced Science, Innovation and Research (MAScIR), 10100 Rabat, Morocco*

[3] *Institute for Solid State Physics and Optics, Wigner Research Centre for Physics, Eötvös Loránd Research Network, Budapest, Hungary*

[4] *I3N and Physics Department, University of Aveiro, 3810-193 Aveiro, Portugal*

[5] *MEE Lab, Faculty of Science Semlalia, University of Cadi Ayyad, 40090 Marrakesh, Morocco*

*Email: najoia.aribou@uit.ac.ma

In nanofluid composites, competing interactions, interplay and proximity effects at the interface between the different constituents often lead to interesting properties physical, sometimes to novel effects and, to new functionalities. In this paper, we focus our interest on the electrical and dielectric properties of graphene oxide (GO)/water nanofluid composite and to their modeling. These properties were reported in the frequency range 100 Hz–15 MHz and in the temperature range from 295 to 309 K. The temperature dependence of the DC electrical conductivity shows a typical effect of the negative temperature coefficient in resistivity (NTCR) of this material. The mechanism responsible for the change in resistivity is probably predominantly tunneling, wherein the GO particles are not in physical contact and the electrons tunnel through the water gap between them. The DC electrical conductivity obeys an Arrhenius law below and above a critical temperature, and allows us to calculate both activation energies. Moreover, the dielectric response was analyzed using complex permittivity and modulus formalisms, depending on the temperature of measurement. A relaxation phenomenon is induced in the nanofluid suggesting that the presence of the GO particles greatly affects the dielectric properties of the water due to the polarization phenomenon created by them. Havriliak–Negami model was used to fit the experimental results.

Keywords: *Nanofluid, complex permittivity, dielectric properties, relaxation, Havriliak-Negami model*

PP-VA06

Ureasilicate organic-inorganic hybrids doped with heteropoly acid

BOEV V.[1,*], ILCHEVA V.[1], LEFTEROVA E.[1], BURDIN B.[1], DIMITROVA M.[1], PETKOVA T.[1]

[1] *Institute of Electrochemistry and Energy Systems, Bulgarian Academy of Sciences, Acad. G. Bonchev str. bl.10, 1113 Sofia, Bulgaria*

***Email :** victor.boev@iees.bas.bg

Main goal of the present work is synthesis of proton-conducting membranes by addition of heteropoly acid in organically modified silicate host materials (ORMOSILS). The samples were obtained by sol-gel approach from two different ureasil organic-inorganic hybrid monomers with different length of polymer segments. The monomers were prepared by rapid uncatalyzed reaction between amino and isocyanate functional groups within compounds of two modified silica ethoxide and polyetheramine. In particular, O,O'-bis(2-aminopropyl)-polypropylene glycol)-block-polyethylene glycol-block-polypropylene glycol-500 (Jeffamine ED-600) and (triethoxysilyl)propyl isocyanate (ICPTES) were used for synthesis of the first monomer and (aminopropyl)triethoxysilane (APTES) and 3-(triethoxysilyl)propyl isocyanate (ICPTES) were used for synthesis of the second monomer respectively. The incorporated heteropoly acid (phosphotungstic acid) acts simultaneously as a source of mobile protons and as a catalyst, initiating the hydrolysis/condensation reactions of the sol–gel composite.

Ionic conductivities, measured at room temperature for the membrane, obtained from the first monomer are of the order of 10^{-5} S/cm and for the second one – about 10^{-8} S/cm.

It was established that the proton conductivity of the membrane, prepared from the first monomer strongly depends on the degree of humidification of the atmosphere at which the measurement is performed. The membrane with lower proton conductivity demonstrated weakly dependent on the humidity of the medium.

Keywords : *Proton conducting membranes, Ureasils, Ionic conductivity*

Acknowledgment: The authors are grateful for the final support of National Scientific Program "Low-carbon energy for transport and domestic use" – E+ (Contract D01-2014 /28.11.2018) with a leading scientific organization Bulgarian Academy of Sciences, BULGARIA.
The study has been carried out using facilities of ESHER funded by the Ministry of Education and Science, Contract No. ДО1-160/2018.

PP-VA07

Investigation of linker rotation dynamics in ZIF-8, ZIF-67 and ZIF-90 metal-organic frameworks using broadband dielectric spectroscopy

M. KINKA[1], S. BALČIŪNAS[1], M. VARNAUSKAS[1], R. GRIGALAITIS[1], A. SOLOVJOVAS[1] AND F.-K. SHIEH[2]

[1] *Faculty of Physics, Vilnius University, Sauletekio av. 9, LT-10222 Vilnius, Lithuania*
[2] *Department of Chemical Engineering, National Taiwan University, Taipei 10617, Taiwan*
Email : martynas.kinka@ff.vu.lt

Metal–organic frameworks (MOFs) - ordered arrays of metal-based inorganic building blocks interconnected by polytopic organic ligands (linkers) - attracted exceptional attention as efficient materials for gas adsorption, separation and future electronics. Choosing of specific metal centers and design of organic linkers allows relatively simple tuning of properties of these materials towards enhancement of their capabilities. Recent studies have shown, that often organic linkers possess some type of flexibility or rotational mobility, which is a contrasting characteristic in respect to other porous materials like zeolites and might be responsible for unique properties of MOFs [1]. Our investigations of dielectric properties of ZIF-90 MOFs showed, that broadband dielectric spectroscopy could be used to probe linker rotation dynamics and the influence of adsorbed molecules [2]. In order to investigate the influence of interexchange of different metal centers and organic linkers we further investigated dielectric properties of ZIF-8, ZIF-67 and ZIF-90 in the 1 Hz – 1MHz frequency and 200 K – 500 K temperature ranges. Analysis of measured complicated dielectric spectra allowed us to distinguish several relaxation processes caused by lattice and adsorbed polar molecule dynamics. Temperature evolution of these relaxation processes and influence of surrounding gas atmosphere was analysed in order to identify and characterise linker rotations in these MOFs.

Keywords : *Metal–organic frameworks, dielectric spectroscopy, ZIF.*

References :

[1] A. Gonzalez-Nelson et al., Nanomaterials 2019, 9, 330; doi:10.3390/nano9030330
[2] S. Balciunas et al., J. Phys. Chem. C 2019, 123, 631−636; doi: 10.1021/acs.jpcc.8b10862

PP-VA08

Encapsulation of TiO_2 nanosized particles in ureasil organic–inorganic hybrid obtained by sol-gel method

ILCHEVA V.[1,*], BOEV V.[1], AVDEEV G.[2], PETKOVA T.[1]
[1] *Institute of Electrochemistry and Energy Systems, Bulgarian Academy of Sciences, Acad. G. Bonchev str. bl.10, 1113 Sofia, Bulgaria*
[2] *Institute of Physical Chemistry, BAS, Acad. G. Bonchev str., bl.11, 1113 Sofia, Bulgaria*
***Email :** vania.ilcheva@iees.bas.bg

In the present work we have summarized recent experimental results about ureasil based organic-inorganic hybrids, with embedded TiO_2 photocatalytic nanoparticles. The ureasilicate materials (ureasils) were synthesized by hydrolysis and condensation of organic – inorganic monomer, prepared by reaction between 3-isocyanatepropyltriethoxysilane (ICPTES) and double terminated polyetheramine (Jeffamine). The initial ureasilicate monomer was doped with various amounts of TiO_2 with an average particle size of ~ 30 nm. Orthophosphoric acid was used as a catalyst for the sol-gel process. In order to achieve sufficiently high gelling rate which ensure a homogeneous particle distribution in the volume of the synthesized ureasilicate material, the concentration of the H_3PO_4 was experimentally determined.

The phase composition, structure and morphology of the prepared samples with embedded TiO_2 particles were characterized by X-ray diffraction analysis, Fourier-transform infrared spectroscopy and scanning electron microscopy. Thermal behavior was examined using thermogravimetric analysis, while the optical properties were studied by electron absorption spectroscopy operating in diffuse reflection mode. Photocatalytic degradation of modeling pollutant malachite green dye was carried out to study the efficiency of the TiO_2-containing ureasil nanocomposite as a photocatalyst under UV irradiation. It was found that the observed degradation of the pollutant is mainly influenced by properties inherent in the ureasilicate material itself.

Keywords: *Ureasil, nanocomposite, photocatalytic nanoparticles*

Acknowledgment: The authors are grateful for the final support of National Scientific Program "Low-carbon energy for transport and domestic use“ – E+ (Contract D01-2014 /28.11.2018) with a leading scientific organization Bulgarian Academy of Sciences, BULGARIA.
The study has been carried out using facilities of ESHER funded by the Ministry of Education and Science, Contract No. ДО1-160/2018.

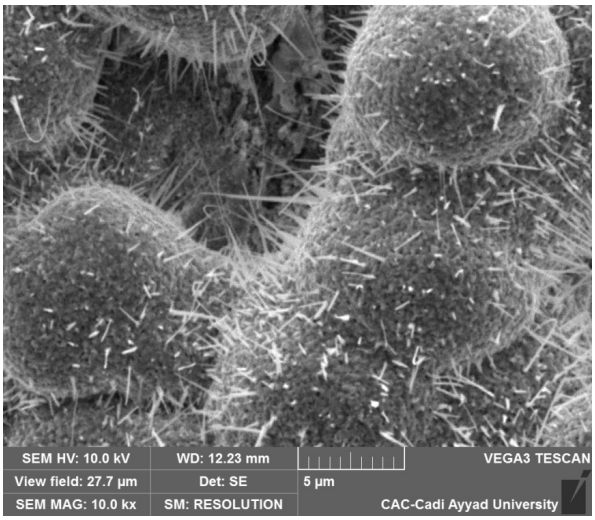
PP-VA09

Optimisation of the density of copper oxide nanowires synthesized by the electrochemical technique followed by annealing

S. ELMASSI*, L. NKHALI, A. NARJIS, A.EL KISSANI, A. OUTZOURHIT

Laboratory of Materials, Energy and the Environment (LaMEE), Faculty of Science Semlalia. Cadi Ayyad University, P. O. Box 2390, Marrakech 40000, Morocco
***Email :** elmassisaid@gmail.com

Copper thin films were synthesized on FTO/glass substrates using the electrochemical technique (in the potentiostatic mode) at 60°C. Copper sulphate and lactic acid were used as procursors. In this work, we report on the synthesis of the of copper oxide nanowires (CuO NWs) by annealing at 400 °C. In particular, we study the effect of the annealing time (taking 4, 6, 8, 10 and 12 hours, respectively) on CuO NWs density. Characterization will be done by X-ray diffraction, UV-vis spectroscopy and Scanning Electron Microscopy. Other parameters can be also optimized like the annealing temperature and the heating rate.



SEM images for the sample synthesized at 2°C/min for 4h

PP-VA10

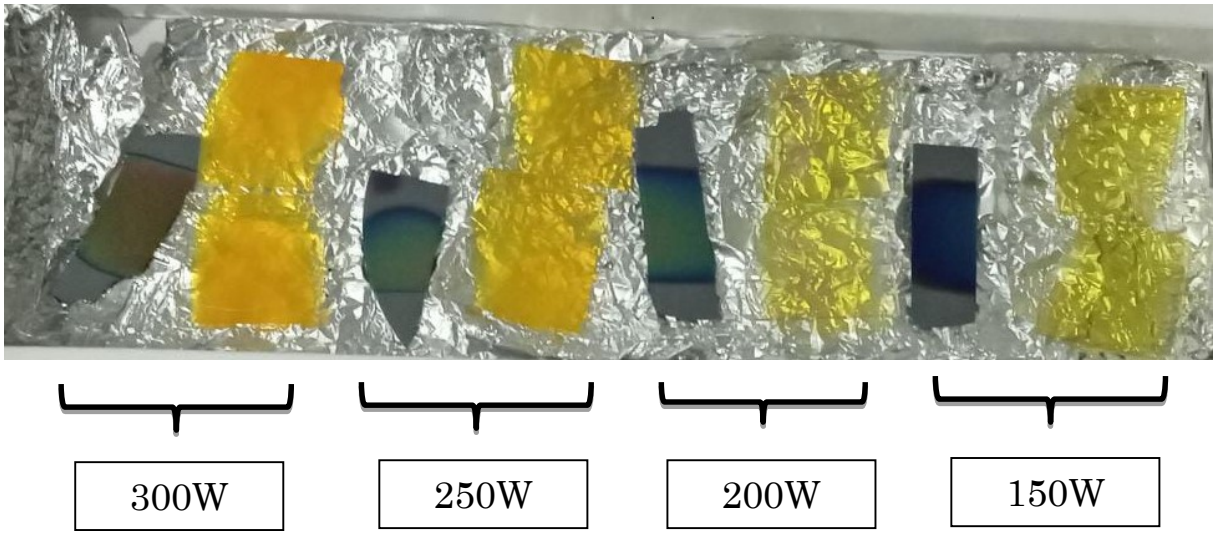
Effect of RF power and annealing on the structural, optical and morphological properties of RF-sputtered V_2O_5 thin films

M.BOUSSETA*, L. NKHALI, A. NARJIS, A. EL HICHOU, A. OUTZOURHIT

Laboratory of Materials, Energy and the Environment (LaMEE), Faculty of Science Semlalia. Cadi Ayyad University, P. O. Box 2390, Marrakech 40000, Morocco

***Email :** mohammed.bousseta@edu.uca.ma*

Thin films of vanadium oxide were deposited on glass and silicon substrates by radio frequency reactive sputtering from a high purity **vanadium** metal target (99.7%) with a diameter of 10 cm. The reactive sputtering was carried out in an Ar:O2 gas mixture containing 10% of O2 and 90% of Ar. The films were deposited at different RF powers (150 W, 200 W, 250 W ,and 300 W) for a fixed deposition time of 180 min. X-ray diffractograms showed that the deposited thin films crystallized in an orthorhombic V_2O_5 phase. It has been found that the crystallite size varies with RF power, and is maximized using 300w of RF power. Scanning electron microscopy (SEM), The Fourier transform infrared (FTIR) spectra and Raman scattering analyzes have confirmed the formation of V_2O_5 thin films. In addition, Optical transmittance measurements were performed using a Shimadzu UV-PC spectrophotometer in the 200–3200 nm range, it is observed that the optical band gap of the films decreases with the increase in the radiofrequency power.



Poster Presentations

(Session VB)

PP-VB01

A comparison of polypropylene-surface treatment by AC corona and dielectric-barrier corona discharges in the air

BOUGHAROUAT A.
Université Akli Mohand Oulhadj de Bouira, Faculté des Sciences et des Sciences Appliquées, Département de Génie Electrique, Bouira 10000, Algeria
Email: ali_boug@live.fr

Corona discharge treatment is widely used and has been proven effective in modifying the surface properties of materials, such as wettability, biocompatibility, and surface roughness. This technique has been shown to be useful in increasing the wettability of polymers, resulting in the activation of polymeric surfaces by increasing their surface energy and hydrophilic nature [1]. AC corona discharge at atmospheric pressure represents one of the most complex forms of electric discharges. Its main advantage is that they are rich sources of chemically active radicals, excited and ionized species [2]. Results are presented from experimental studies of polypropylene (PP) films treated by AC corona discharge (point-plan electrode) and AC dielectric barrier corona discharge with point and a dielectric-coated plate electrode configuration the voltage frequency f = 1 kHz. Hydrophobicity of these polymer film surfaces was studied by contact angle measurements. The surface energy of the polymer films was calculated from contact angle data using harmonic mean method. The results show that the corona discharge treatment induces a rapid reduction in the contact angle compared to that recorded with the corona dielectric barrier discharge treatment. All measurements show a typical exponential $\boxed{[\sim(1-\mathrm{e}^{-at})]}$ dependence of the polar surface tension on the treatment time t. The increase can be characterized by a rate constant a, describing the first order kinetic of the process. Furthermore, a saturation surface tension can be defined, which is independent on the peak voltage used and of all discharge parameters, whereas the time constant depends strongly on the type of discharge. The FT-IR/ATR, SEM, and XPS results showed that AC corona treatment was bigger effectively improve in the wettability of polypropylene surface than the AC dielectric-barrier corona discharges.

Keywords: *AC Corona discharge, AC dielectric barrier corona discharge, polypropylene.*

References :

1- Adnan Carsimamovic[a]*, Adnan Mujezinovic[b], Salih Carsimamovic[b], Zijad Bajramovic[b], Milodrag Kosarac[a], Koviljka Stankovic[c] "Analyzing of AC Corona Discharge Parameters of Atmospheric Air", the 6th International Conference on Sustainable Energy Information Technology (SEIT 2016), Procedia Computer Science 83 (2016) 766 – 773.

2-Yu. S. Akishev, A. V. Dem'yanov, V. B. Karal'nik, A. E. Monich, and N. I. Trushkin, " Comparison of the AC Barrier Corona with DC Positiveand Negative Coronas and Barrier Discharge", Plasma Physics Reports, Vol. 29, No. 1, 2003, pp. 82–91.

PP-VB02

Effect of different plasma working gas mixtures on the decontamination of fungus polluted water

Houssem Eddine BOUSBA[1,*], Saoudi MOUNA[2], Salah SAHLI[1], Namous WAIL SEIF EDDINE[1], Lyes BENTERROUCHE[1]

[1] *Laboratory of Microsystems and Instrumentation (LMI), Electronic department, Faculty of Technology, University Frères Mentouri, Constantine – Algeria*

[2] *Laboratory of molecular and cellular biology, Faculty of Nature and Life Sciences, University Frères Mentouri, Constantine – Algeria*

E-mail: bousba.houssemeddine@umc.edu.dz

Atmospheric pressure plasma jets (APPJs) are known to have an anti-microbial potential. A setup has been adapted for plasma based liquid treatment where the APPJ is obtained at the exit of a long plastic tube by inserting a floating copper wire inside it. This allows the transport of sufficient energy to regenerate the plasma jet; which has been completely immerged in water contaminated with fungus in order to obtain plasma activated water (PAW). Studies has found that plasma activated water has a particular potential of limiting or/and preventing micro-organisms growth and reproduction as it contains relatively high concentrations of Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS). Those chemical species generated with the intermediate of plasma in PAWs are the main responsible factors of its anti-microbial activity. The type nature and also the concentration of those species are found to be highly related to the nature of the working gas used to ignite plasma[1, 2].

The effect and efficiency of different working gases has been investigated; He + air, He + O_2 and He + N_2O have been introduced separately through the plasma reactor for a direct treatment of the fungus contaminated water. The active species in plasma are obtained following specific physiochemical reactions that differ from gas to another. The study has been performed on two types of funguses the *Fusarium culmorum* and the *Alternaria graminicola*, those funguses are from different families, however both are known to be highly infectious to plants and seeds and even crops.

The results illustrate the treatment based on He + N_2O as working gas leads to water decontamination in the average of 5 minutes while the mixture of He + Air takes up to 25 minutes. In contrast the use of He + O_2 is found to have an opposite effect as it allows the growth of both funguses after treatment.

Keywords: *plasma, water decontamination, fungus, reactive Nitrogen species, reactive Oxygen species.*

References:

[1] R. Zhou *et al.*, "Plasma-activated water: generation, origin of reactive species and biological applications," *Journal of Physics D: Applied Physics,* vol. 53, no. 30, p. 303001, 2020.

[2] C. Bradu, K. Kutasi, M. Magureanu, N. Puač, and S. Živković, "Reactive nitrogen species in plasma-activated water: generation, chemistry and application in agriculture," *Journal of Physics D: Applied Physics,* vol. 53, no. 22, p. 223001, 2020.

PP-VB03

Influence of the Metal/Dielectric Contact on the Reliability of the Insulation Electrical Systems

BELDJILALI A., SALHI F., SAIDI-AMROUN N. AND SAIDI M.
USTHB , Faculty of Physics, Laboratory of Materials Physics, Po.Box 32, El-Alia, Bab-Ezzouar, DZ-16111 Algiers, Alegria
Email : abdeslembeldjilali@gmail.com

The proper operation of power equipments remains the main objective each time sought, the possibilities for reaching this goal are strongly dependent on the performances of the dielectric materials used as insulation. Several, intrinsic and extrinsic, parameters like aging, operating conditions, environmental constraints…are considered as the mainly causes of performances declining of the insulation system. Recently, we have examined another parameter suspected to play a role in this problematic; it concerns an electrostatic phenomenon directly related to the designing of this kind of apparatus. In fact, the inevitable putting in contact of dielectric and metallic materials, into the power transformers, lead necessary to the formation of metal/dielectric interfaces, which certainly act on the electrical behavior of this kind of equipments. By changing the nature of the metal used, different metal/liquid and metal/paper contacts are realized and then tested with the PDC technique for different levels of the electrical stress. In this survey, thin films of dielectric samples are submitted, between two planar metallic electrodes, to DC voltages and the electrical current circulating through the dielectric is recorded with a high sensitive electrometer. Since only the metal natures of the electrodes are changed, the parameters suspected to acts on the measured current are the electrodes conductivities and/or their work function. By quantifying the involved electrical charges, these interfaces are compared under the applied voltage and after removing of the electrical stress. The obtained results are interpreted, as occurrence of an electrostatic possess at the metal/dielectric interface, which may initiate the pre-breakdown processes. In fact, the results indicate a predominance of the work function parameter vs. the metal's conductivity; this indicates possibility of creation at the metal/dielectric contact of addition

Keywords : *Dielectrics, Electrical insulation, Space charge Conduction, work function.*

PP-VB04

A possible crosslinking behavior of crosslincable Silane-XLPE HV insulation under cyclic accelerated weathering aging

AFEISSA S.[1], BOUKEZZI L.[1], BESSISSA L.[1], GUESSAB O.[2], LOUCIF A.[3]
[1] *Materials Science and Informatics Laboratory, MSIL, University of Djelfa, Algeria*
[2] *Faculty of Sciences of Nature and Life, University of Djelfa, Algeria*
[3] *ENICAB, Industrial Zone, Biskra, Algeria*
Email: sadiasouq@gmail.com

Silane-crosslinked polyethylene (Si-XLPE) is the first candidate polymer that can be used in the photovoltaic systems connection cables because its resistance to the weathering conditions. The idea of the carried out work in this paper is how we can benefit from the existing weathering conditions that looked to be similar to those necessary in silane-cross-linking process of polyethylene to enhance the crosslinking capability? The adopted methodology consists to conduct a long-term cyclic accelerated weathering aging in the QUV aging test cell on the extruded silane-grafted polyethylene films (cross-linkable polyethylene). The possible crosslinking behavior and the photo and thermo-oxidation degradation were assessed by macroscopic (Hot-Set-Test and mechanical properties) and microscopic (FTIR) technics. The obtained results highlight that the applied cyclic weathering aging leads to an outcome crosslinking reaction. The crosslinking degree increases progressively with aging time leading to an elastic behavior of the polymer. More the crosslinking degree increases more the Hot-Set-Test elongation decreases. The macroscopic observations agree well with the FTIR measurements where we have noticed big changes in the digital fingerprint of the material. The changes in the digital fingerprint are caused by transformation of silane into Si-O-Si links. The absorption band of Si-O-Si links at 1030 cm^{-1} was found to be increase with aging time. Beside this, it is evidenced from our study that mechanical properties and carbonyl index behave in very similar way (increase in the former leads to the decrease in the latter in each case) which put in evidence that the same mechanisms are responsible for both behaviors. The probable scenario for this behavior is that the oxidation process leads to chain session process. The chain session has a dramatic effect on the mechanical properties that decrease in fast way. The overall conclusion is that the possible crosslinking is done in three steps: initiation, propagation and termination.

Keywords : *Silane-XLPE, Weathering aging, QUV, Hot-Set-Test, FTIR.*

References:

[1] A. Hedir, M. Moudoud, O. Lamrous, S. Rondot, O. Jbara, P. Dony, Ultraviolet radiation aging impact on physicochemical properties of crosslinked polyethylene cable insulation, Journal of applied Polymer Science, vol. 137, N° 16, 48575, 2020.
[2] J.V. Gulmine, P.R. Janissek, H.M. Heise, L. Akcelrud, Degradation profile of polyethylene after artificial accelerated weathering, Polymer Degradation and Stability, vol. 79, pp 385–397, 2003.
[3] S.M. Tamboli, S.T. Mhaskie, D.D. kale, Crosslinked polyethelene, Indian journal of chemical technology, vol. 11, pp 853-864, 2004.
[4] N. Mostofi Sarkari, M. Mohseni, M. Ebrahimi, Examining impact of vapor-induced crosslinking duration on dynamic mechanical and static mechanical characteristics of silane-water crosslinked polyethylene compound, Polymer Testing vol., 93, 106933, 2021.
[5] R.P. de Melo, V. de O. Aguiar, M. de F.V. Marques, Silane crosslinked polyethylene from different commercial PE's: influence of comonomer, catalyst type and evaluation of HLPB as crosslinking coagent, Materials Research, vol. 18, PP 313–319, 2015.
[6] J. Morshedian, P. Hoseinpour, Polyethylene crosslinking by two-step silane method: a review, Iranian Polymer Journal, vol. 18 pp 103–128, 2009.

[7] A. Xu, S. Roland, X. Colin, Physico-chemical characterization of the blooming of Irganox 1076® antioxidant onto the surface of a silane-crosslinked polyethylene, Polymer Degradation and Stability, vol. 171, 109046, 2020.

[8] M. Celina, G. A. George, Characterisation and degradation studies of peroxide and silane crosslinked polyethylene, Polymer Degradation and Stability, vol. 48, pp 297-312, 1995.

[9] K. Sirisinha, S. Chimdist, Comparison of techniques for determining crosslinking in silane-water crosslinked materials, Polymer Testing, vol. 25, pp 518–526, 2006.

[10] S. F. Chabira, M. Sebaa, C. G'sell , Influence of climatic ageing on the mechanical properties and the microstructure of low-density polyethylene ilms, Journal of Applied Polymer Science, vol. 110, pp 2516–2524, 2008.

PP-VB05

Electrical and optical properties of room temperature potassium niobate single crystals

CHAIB H.[1], AMOUNAS S.[1], HBAB A.[1], AIT ELHAJ D.[1] , AIT-TALEB T.[1], TIRBIYINE A.[2], NAFIDI A.[3]

[1] *Polydisciplinary Faculty of Ouarzazate, Ibn Zohr University, Morocco*
[2] *Faculty of Applied Sciences of Ait-Melloul, Ibn Zohr University, Morocco*
[3] *Faculty of Sciences of Agadir, Ibn Zohr University, Morocco*
Email : h.chaib@uiz.ac.ma

Potassium niobate ($KNbO_3$), a perovskite-type ferroelectric material isostructural to barium titanate ($BaTiO_3$), falls among the most known technologically relevant ferroelectric oxide materials having large spontaneous polarization, remarkable optical anisotropy and interesting nonlinearities for optical and electrooptical applications in single monodomain crystals as well as in periodically poled optical superlattices (PPKN). At room temperature this material belongs to the orthorhombic mm2 class with cell parameters a=5.6896Å, b=3.9692Å and c=5.7256Å and spontaneous polarization (P^{spn}=0.41C/m^2) paralell to the c-axis. In contrast to $BaTiO_3$ and $PbTiO_3$, $KNbO_3$ is, at room temperature, a biaxial material having three refractive indices n_1=2.2801, n_2=2.3296 and n_3=2.1687 (n_2>n_1>n_3) for light polarized, respectively, paralell to the three crystallophysic axes a, b and c of the nonprimitive orthorhombic unit cell. Similar to $BaTiO_3$, $KNbO_3$ has four phases: the first is centrosymmetric non ferroelectric with a cubic structure stable at high temperature, while the three others are non-centrosymmetric ferroelectric with a tetragonal, orthorhombic and rhombohedral structure stable, respectively, below the transition points at T_{CT}=418°C, T_{TO}=203°C and T_{OR}=-50°C.

Here we present a theoretical approach for studying the spontaneous polarization and refractive indices of orthorhombic $KNbO_3$ at room temperature. Our approach, which is a microscopic quantum model based upon the orbital approximation and the dipole-dipole interaction due to the local electric field acting on the constituent ions, takes into account the anisotropy in the first-, second- and third-order electronic polarizabilities of all constituent ions, their ionic shifts as well as the crystalline deformations.

The calculation shows that the experimental data of the spontaneous polarization and refractive indices is successfully explained by considering the nonlinearity and anisotropy of the first-, second- and third-order electronic polarizabilities of the constituent ions, particularly that of the O_{II} and O_{III} ions. Furthermore, The local electric fields of these two ions are inclined in the xz-plane, respectively, by θ=-45.76° and θ=+45.76 to the polar axis. P^{spn} is found to measure 0.4695C/m^2, while n_1, n_2 and n_3 are 2.2508, 2.3540 and 2.2378, respectively.

Keywords: *Potassium niobate, Spontaneous polarisation, Refractive indices, Ionic shifts, Crystalline deformations, Electronic polarizabilities, Orbital approximation, Dipole-dipole interaction.*

PP-VB06

DFT investigation of structural, electronic and optical properties of lithium niobate in its ferroelectric phase

HBAB A.[1], AMOUNAS S.[1], CHAIB H.[1], AIT-TALEB T.[1], NAFIDI A.[2]
[1] *Polydisciplinary Faculty of Ouarzazate, Ibn Zohr University, Morocco*
[2] *Faculty of Sciences of Agadir, Ibn Zohr University, Morocco*
Email : abdellah.hbab@edu.uiz.ac.ma

Lithium niobate ($LiNbO_3$) belongs to the class of ferroelectric oxides, like lithium tantalate ($LiTaO_3$) and barium titanate ($BaTiO_3$). Due to its large spontaneous polarization, its remarkable optical anisotropy and its non-linear optical activity, $LiNbO_3$ has many technological applications in the fields of optoelectronics, acoustoelectronics and photonics. $LiNbO_3$ has only two phases, both with trigonal symmetry: the first phase, which is stable below the Curie temperature (T_c = 1210 °C), is a ferroelectric phase with the space group R3c; the second phase, which is stable above the Curie temperature, is a paraelectric phase. In this work, we present a theoretical study of the structural, electronic and optical properties of the ferroelectric phase of lithium niobate single crystals. The calculations were carried out using the pseudopotential method with an exchange correlation functional considering the local density approximation (LDA) within the framework of the density functional theory (DFT) using Quantum Espresso package. The results show that the calculated value of the energy gap at the centre of the Brillouin zone, which is 2.54 eV, is underestimated compared to the experimental value. Moreover, the upper valence band and the lower conduction band consist mainly of the O-2p and Nb-4d states. Furthermore, by using the modern theory of polarization, the calculated spontaneous polarization of lithium niobate, which is 0.74 C/m^2, is in good agreement with the measured value. The ordinary and extraordinary refractive indices as well as the optical birefringence are also discussed as a function of the wavelength of the incident light.

Keywords: *Lithium niobate, Density Functional Theory, Quantum Espresso, Electronic properties, optical properties.*

PS

PS-C01

Utlra-Wideband Planar Multilayer Absorber Based on Long Carbon Fibers Loaded Epoxy Foam Composites

EL ASSAL A., BREISS H., BENZERGA R., SHARAIHA A.
Univ Rennes 1, CNRS, IETR – UMR 6164, F-35000 Rennes, France
Email: ratiba.benzerga@univ-rennes1.fr

For multilayer absorbers, electromagnetic (EM) waves should be transmitted from one layer to another with minimal reflections between the different layers, and with a gradual dissipation inside these layers. Therefore, a gradual decrease of impedance, and so, increase of the complex dielectric and/or magnetic properties in depth should be ensured. Moreover, today, in commercial multilayer absorbers, the same thickness is used for each layer; this thickness can be monitored in order to optimize the absorption performance of the multilayer. However, it is difficult to choose the appropriate dielectric properties and thickness of each layer amongst a big database of materials. Therefore, genetic algorithm (GA) optimizer could be used.

In our lab, carbon fibers (CFs) loaded epoxy foam composites are studied as EM absorbing materials. Different lengths and weight percentages of the CFs are used, thus allowing to a large panel of dielectric properties.

In this work, a MATLAB code is developed to calculate the reflection coefficient of a multilayer absorber. The GA optimizer is associated to this developed code in order to test, within different iterations, different thickness and compositions of the layers, in order to achieve the reflection coefficient of our goal.

Our optimization allows to a multilayer absorber MLA98-GA, with 98 mm total thickness. The simulation result of this multilayer presents a reflection coefficient less than -20 dB in the entire studied frequency range between 0.75 and 18 GHz. This prototype is achieved and measured; this measurement is compared to simulation one and to the performance of commercial multilayer absorber.

Keywords: Multilayer absorber, genetic algorithm, ultra-wide band, absorption.

PS-C02

Hybrid material to broaden the absorption bandwidth of a metamaterial absorber

EL ASSAL A., BREISS H., BENZERGA R., SHARAIHA A.
Univ Rennes 1, CNRS, IETR – UMR 6164, F-35000 Rennes, France
Email: ratiba.benzerga@univ-rennes1.fr

Many efforts have been made in the literature to broaden the absorption bandwidth of electromagnetic metamaterial (MM) absorbers. From them, we may cite: combining multiple resonators, stacking different MMs in a multilayer structure, stacking metallic/dielectric layers in pyramidal or cylindrical forms, or incorporating lumped elements into the MM resonators. Most of these methods have failed to cover several bands; indeed, these methods have mostly focused on only one or two frequency bands among the C, X, Ku or K bands, and only few MM designs were reported so far for the absorption in the S-band. The objective of this work is, firstly, to propose a novel MM absorber with multiple resonances in the frequency band between 2 and 18GHz, and secondly, to broaden the absorption bandwidth, using a simple method, of this MM absorber.

In this work, the design of the proposed MM will be presented; it consists of unit cell with dimensions of 15x15mm², composed of different symmetrical resonators, made of copper layer deposited on FR-4 dielectric substrate of 3.2mm thickness. The simulation and the measurement of the reflection coefficient of this MM are conducted; they show a very good matching thus confirming the multi-resonant structure that exhibits several distinct resonances between 2 and 18GHz.

In order to broaden the absorption bandwidth of the proposed MM absorber, a compact hybrid absorber is made by the association of a thin (13mm) and planar dielectric absorbing layer (based on carbon fiber loaded epoxy foam) to the front of a multi-resonant MM. A reflection coefficient less than -10dB (absorption higher than 90%) is then obtained for this hybrid material between 2.6 and 18GHz by simulation and by the measurement of the achieved prototype.

Finally, a comparison between the obtained results and thus of literature will be made in term of thickness and absorption bandwidth.

Keywords: *Metamaterial, hybrid absorber, ultra-wide band, absorption.*

PS-C03

Comparison of poled glass SIMS data with concentration profile simulations and corresponding refractive index

Petar PERVAN[1], Jordi SANCHO-PARRAMON[1], Boris OKORN[1], V. JANICKI[1]
[1]*Ruđer Bošković Institute, Division of materials physics, Laboratory for optics and optical thin films, Bijenička cesta 54, 10000 Zagreb, Croatia*
Email : ppervan@irb.hr

Glass poling is a process in which alkali and earth alkali ions from near surface volume of glass drift into the bulk of the sample under the influence of the electric field and moderately elevated temperature. There is a significant interest in glass poling due to its possibility to produce waveguides, glass-metal nanocomposites and microstructures on the glass surface. Glass poling is a complex process involving several types of ions and parameters such as temperature, electric field strength, various atmospheres,... Poling is still not understood well enough, so a better theoretical framework could elucidate the underlying processes. Poling process was investigated by comparison of experiment and simulation. Dielectric constant (refractive index) depth profile of the poled glass was modelled and compared to ion concentration depth profile provided by SIMS (secondary ion mass spectroscopy). Also, ion concentration depth profile of soda-lime glass was simulated using numerical differential equations. Model presumption is that time evolution of ion concentration is guided by drift and diffusion currents. Spatial variation of the electric field upon redistribution of charges with respect to their initial concentration is guided by one dimensional Poisson equation. Broader theoretical knowledge of the poling process was acquired by optimising the properties of mobile ions contained in glass.

Keywords: *thermal glass poling, concentration profiles, diffusion, optical chatacterization*

PS-C04

Characterization of Liquid Crystals recovered from End-of-Life Liquid Crystal Displays using Dielectric Spectroscopy

BARRERA A.[1], BINET C.[1], DUBOIS F.[2], HEBERT PA.[3], SUPIOT P.[1], FOISSAC C.[1] AND MASCHKE U.[1]

[1]*Univ. Lille, CNRS, INRAE, Centrale Lille, UMR 8207 – UMET – Unité Matériaux et Transformations, 59000 Lille, France.*

[2]*Univ. Littoral Côte d'Opale, UR 4476, UDSMM – Unité de Dynamique et Structure des Matériaux Moléculaires, 62228 Calais, France.*

[3]*Univ. Littoral Côte d'Opale, UR 4491, LISIC – Laboratoire d'Informatique Signal et Image de la Côte d'Opale, 62228 Calais, France.*

Email : frederic.dubois@univ-littoral.fr

For several decades, Liquid Crystal Displays (LCDs) have been widely used in televisions, laptops, mobile phones, and other devices. Nowadays, LCs represent an important economic value of the recycling system of LCDs. The reuse of these organic molecules could become a profitable basis since it allows to preserve the value of these materials.

In the present work, the dielectric properties of recycled LCs (non-purified, purified and doped with diamond nanoparticles (DNPs) at 0.05, 0.1 and 0.2 weight%) were investigated. The LC mixtures were obtained from industrial recycling of end-of-life LCDs, presenting mainly a nematic phase. A particular interest is given to DNPs to study their impact on mobile ions present in the recovered LCs. Dielectric measurements were carried out using an impedance analyzer on a frequency range from 0.1 to 10^6 Hz, and the anchoring conditions were investigated (planar and homeotropic alignments). All experiments were performed at room temperature and the amplitude of the oscillating voltage was fixed at 1 V. Results show that the dielectric anisotropy for all purified samples presents positive values and a decrease was detected after the addition of DNPs to the LC mixtures. DC conductivity values were obtained by applying the universal law of dielectric response proposed by Jonscher. In addition, results reveal that the conductivity of the doped mixtures is lower than that of the undoped and non-purified LC in planar and homeotropic alignments.

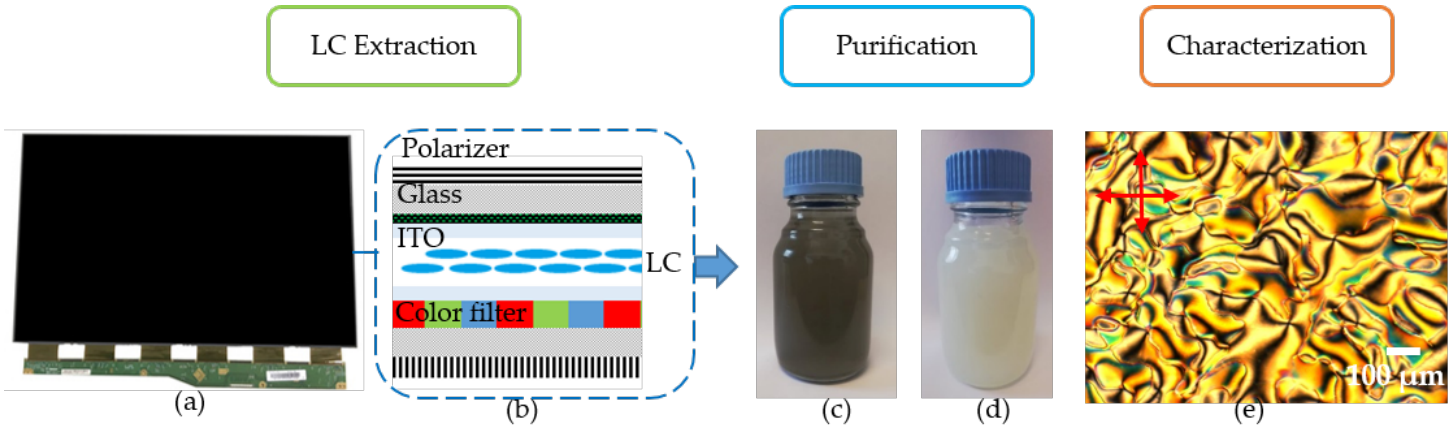


Figure 1: (a) End-of-life LCD, (b) Composition of LCD, (c) Non-purified and (d) purified LCs mixtures and (e) Texture of purified LC mixtures observed under polarizing optical microscope presenting a nematic Schlieren texture. Conditions: Crossed polarizers and room temperature.

Keywords : *nematic liquid crystals; recycling; dielectric properties.*

PS-C05

Dielectric properties of dispersions of nanoparticles in polymer/liquid crystal films

DUBOIS F.[1], BARRERA A.[2], BOUBERKA Z.[2,3], ELOUALI M.[2], AND MASCHKE U.[2]
[1]*Univ. Littoral Côte d'Opale, UR 4476, UDSMM – Unité de Dynamique et Structure des Matériaux Moléculaires, 62228 Calais, France.*
[2]*Univ. Lille, CNRS, INRAE, Centrale Lille, UMR 8207 – UMET – Unité Matériaux et Transformations, 59000 Lille, France.*
[3]*Laboratoire Physico-Chimie des Matériaux-Catalyse et Environnement (LPCMCE), Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf (USTO-MB), El M'naouar, 31000 Oran, Algeria*
Email : frederic.dubois@univ-littoral.fr

Hybrid materials composed of acrylate polymer, nematic liquid crystal and diamond nanoparticles (average diameter 10µm) were elaborated by a phase separation process induced by UV-visible light and studied by different means such as differential scanning calorimetry, polarized optical and scanning electron microscopies, electro-optical and dielectric characterization devices. Several concentrations of liquid crystal (50 to 70 weight-%) and diamond nanoparticles (0 to 1 weight-%) have been employed.
The morphology of the elaborated polymer/liquid crystal systems depends in particular on curing light intensity and diamond concentration; when the latter one is higher than 0.25 weight-%, aggregation of nanoparticles is observed. Otherwise, calorimetric measurements show that the presence of diamond leads to a decrease of both polymer glass transition and nematic-isotropic transition temperatures.
Furthermore, even a small concentration of diamond nanoparticles greatly influences the electro-optical response of the prepared polymer/liquid crystal/diamond systems. In particular, the studied materials present higher switching voltages and lower transmittance in the ON state, compared to the system without diamond nanoparticles. Electro-optical measurements were carried out as function of film thickness.
The dielectric investigation focused primarily on the determination of permittivity, conductivity, and dielectric loss of these hybrid materials in a frequency range comprised between 20Hz and 1MHz. In particular, the presence of diamond nanoparticles allows a strong reduction of the electrical conductivity.

Keywords : *nematic liquid crystals; nanoparticles; dielectric properties.*

PS-C06

High power microwave absorbers based on glass foam composites

BENZERGA R.[1], LAUR V.[2], LE GENDRE L[1]., KABALAN A.[1], LEBULLENGER R.[3], SHARAIHA A.[1]

[1] *Univ Rennes, CNRS, IETR-UMR 6164, 35000 Rennes, France*
[2] *University of Bretagne Occidentale, CNRS, Lab-STICC - UMR 6285, 29000 Brest, France*
[1] *Univ Rennes, CNRS, ISCR – 6226, 35000 Rennes, France*
Email: ratiba.benzerga@univ-rennes1.fr

In order to save natural resources and reduce energy costs, glasses are often remelted and recycled. But while conventional glasses from bottles and jars are 100% recyclable and reused in the production of new containers, special glasses pose a tougher problem. As heavy-metals containing materials, glass wastes from electronic industry need to be treated separately in a specific recycling branch, if that were at all economically viable. The Cathode Ray Tubes (CRT), found in older style TV screens and monitors, are such emblematic e-wastes from glass industry. Mainly polluted with lead, strontium and barium, those CRT TVs and computer monitors form hazardous waste piles and, as this technology is obsolete, they cannot be used as a raw material again. Foam glass manufacture is a promising mode for re-using these CRT glasses; depending on the foaming process, this cellular material combines low density, low thermal conductivity and excellent thermal stability. For this work, we focused our attention on EM absorptive properties of those CRT cullet based glass foams. Inorganic additives can be used to reinforce the shielding properties in a microwave range. Indeed, when carbon is used as the foaming agent, high dielectric losses are observed in the X-band, making of these foams a good candidate for EM absorbing applications [1,2]. In this work, we will first show the impact of the carbon rate on the density and the microwave behavior of these glass foams. Then, the simulation and the measurement results of the thermal stability and the high power microwave absorbing application of these composites will be presented and discussed.

Key Words: *Glass foam, electromagnetic absorption, carbon, CRT, porous structures*

References :

3. R. Benzerga, V. Laur, R. Lebullenger, L. Le Gendre, S. Genty, A. Sharaiha, P. Queffelec, Materials Research Bulletin 67 (2015) 261–265.
4. V. Laur, R. Benzerga, R. Lebullenger, L. Le Gendre, G. Lanoë, A. Sharaiha, P. Queffelec, Materials Research Bulletin 96 (2017) 100–106.

PS-C07

Effect of fiber length on microwave absorption frequency band of composites based on carbon fiber loaded epoxy foam

BREISS H.[1,2], EL ASSAL A.[1,2], BENZERGA R.[1], SHARAIHA A.[1], HARMOUCH A.[2], JRAD A.[2]

[1] *Univ Rennes, CNRS, IETR-UMR 6164, F-35000 Rennes, France.*
[2] *Université Libanaise, EDST, Tripoli, Liban*
Email : hanadi.breiss@univ-rennes1.fr

Over the past decade, carbon fibers (CFs) have attracted worldwide interest as reinforcement in composite materials for several applications thanks to their electrical conductivity, high corrosion resistance, low density and low cost. Moreover, the composites loaded with carbon fibers have received great attention due to the high electrical conductivity of the fibers which make such composites as ideal candidates for electromagnetic (EM) shielding, for which, high microwave dielectric properties are needed.

In our team, we proposed light-weight epoxy foam filled with very low weight percentages (< 1 wt.%) of CFs as microwave absorbing material. The low real part of the permittivity and high dielectric losses of this material make it ideal for the absorbing application. It is developed as an alternative solution of the commercial polyurethane absorbers loaded with volatile carbon black used in anechoic chambers. Compared to commercial absorbers, our materials showed a very good absorption performance with very low CFs loads. Since, different studies were conducted on the optimization of the dispersion of CFs in the epoxy matrix and on the dielectric properties of these materials as a function of amount and length of carbon fibers.

In this paper, the effect of carbon fiber length on EM absorption, especially on the absorption frequency band, is investigated. Measurement, in free space, of the dielectric properties of different composite samples shows a relation between the absorption frequency band and the length of carbon fiber. This relation appears clearly on the measurement of the reflection coefficient of samples. Furthermore, to confirm this relation, prototypes loaded with longue or short carbon fiber length are realized and characterized. Results confirm an improvement in absorption performance on the low frequency or high frequency depending on the choice of CFs length. These results are also compared to the performance of the commercial absorbers.

Keywords : *Carbon fibers, Dielectric materials, Microwave absorption, Epoxy foam, composites*

PS-C08

Fabrication of well-controlled ferroelectric tunnel nano-junctions in P(VDF-co-TrFE) thin films by using Conductive-AFM

DALLA FRANCESCA K.[1], FERRI A.[1], DA COSTA A.[1], MAËS L.[1], JAHJAH W.[2], NACHAWATY A.[3], CHEN L.[3], LE BRETON J-C.[2], CHSHIEV M.[4], SCHIEFFER P.[2], LU Y.[3], DESFEUX R.[1]

[1] *Univ. Artois, CNRS, Centrale Lille, Univ. Lille, UMR 8181, Unité de Catalyse et Chimie du Solide (UCCS), F-62300 Lens, France*

[2] *Univ. Rennes, CNRS, Institut de Physique de Rennes (IPR), UMR 6251, Beaulieu, 263 avenue du General Leclerc, 35042 Rennes, France*

[3] *Univ. Lorraine, CNRS, Institut Jean Lamour (IJL), UMR 7198, Campus ARTEM, 2 Allée André Guinier, 54011 Nancy, France*

[4] *Univ. Grenoble Alpes, CEA, CNRS, Grenoble INP, INAC-SPINTEC, 38000 Grenoble, France*

Email: antonio.dacosta@univ-artois.fr

In the frame of the FEOrgSpin project (*Ferroelectric control of organic/ferromagnetic spinterface*) funded by the National *French* Research Agency (ANR), one of the objectives is to control the hybrid ferroelectric organic/ferromagnetic metal interface, as known as "spinterface", for the development of future advanced data storage devices based on spin electronics. For example, the spin polarization of spinterface at the Fermi level can be different or even of opposite sign to that of the adjacent ferromagnetic electrode, annihilating the spin properties of the device.

Recently, we demonstrated the possibility of modulating the spin polarization at the poly(vinylidene fluoride) (PVDF)/Co interface by changing the direction of the ferroelectric polarization within the PVDF material [1]. We obtained important results regarding the surface morphology, the conduction properties as well as piezo-/ferroelectric behaviour of these organic ferroelectric barrier layers by using different techniques/tools of Atomic Force Microscopy (AFM), such as Piezoelectric Force Microscopy, for nanoscale investigation. Now, in order to optimize the parameters of spin transfer, it becomes necessary to develop nanometric-size organic tunnel junctions to improve the effects of both electroresistance (TER) and magnetoresistance (TMR) [2]. The solution chosen consists in the development of tunnel nano-junctions indentation by the use of conductive-AFM probes (CT-AFM) [3]. Here the feedback control of the process is operated by the current measurement during indentation and allows for a sub-nanometer control of the thickness of the junction.

Keywords: *Tunnel nano-junctions, P(VDF-co-TrFE), Fabrication, Control, Conductive-AFM*

References :

[1] S. H. Liang et al., Adv. Mater. **28** (2016)

[2] B.B. Tian et al., Nat. Commun. **7** (2016).

[3] K. Bouzehouane et al., Nano Lett. **3** (2003).

PS-C09

2D material dependence on the crystallization and ferroelectric properties in organic P(VDF-co-TrFE) thin films

DALLA FRANCESCA K.[1], JAHJAH W.[2], DA COSTA A.[1], NACHAWATY A.[3], DEVAUX X.[3], LE BRETON J.-C.[2], SCHIEFFER P.[2], DESFEUX R.[1], LU Y.[3], FERRI A.[1]

[1] *Univ. Artois, CNRS, Centrale Lille, Univ. Lille, UMR 8181, Unité de Catalyse et Chimie du Solide (UCCS), F-62300 Lens, France*

[2] *Univ. Rennes, CNRS, Institut de Physique de Rennes (IPR), UMR 6251, Beaulieu, 263 avenue du General Leclerc, 35042 Rennes, France*

[3] *Univ. Lorraine, CNRS, Institut Jean Lamour (IJL), UMR 7198, Campus ARTEM, 2 Allée André Guinier, 54011 Nancy, France*

Email: antonio.dacosta@univ-artois.fr

Ferroelectric polymer/2D materials hybrid systems have received considerable attention due to their promising utilization in advanced flexible electronics [1]. It is well-known that the crystallization process of ferroelectric polymers such as poly(-vinylidene fluoride-trifluoroethylene) (P(VDF-co-TrFE)) strongly affects the electronic properties of the hybrid structures.

Here, the effect of graphene and hexagonal boron nitride (*h*BN) 2D materials onto the structural, morphological, and piezoelectric/ferroelectric properties of P(VDF-co-TrFE) thin films is reported. Particularly, the 2D material dependence on both the polarization switching behavior and the piezoelectric coefficient is locally demonstrated. Indeed, it is shown that coercive voltage does not only depend on the P(VDF-TrFE) crystallization temperature and the subsequent thermal treatment. The relationship between structure and piezoelectric/ferroelectric properties is then established. These findings provide useful guidance for fabricating P(VDF-co-TrFE)/2D layer-based flexible electromechanical devices with enhanced performances.

Keywords: *Piezoelectricity, Ferroelectricity, P(VDF-co-TrFE), Atomic Force Microscopy, Graphene, Hexagonal boron nitride*

References :

[1] S.-H. Bae *et al.*, *ACS Nano* 2013, **7**, 3130–3138.

PS-C10

Electric field assisted dissolution of Al and Cu metal thin films

V. BLAŽEK BREGOVIĆ, P. PERVAN, V. JANICKI, J. SANCHO-PARRAMON
Ruđer Bošković Institute, Division of Materials Physics, Laboratory for Optics and Optical Thin Films, Bijenička cesta 54, 10000 Zagreb, Croatia
Email: vblazek@irb.hr

Metal doped silica glass is widely used in photonics, photoelectronis, optics as well as in sensing. There are several methods for doping the glass matrix with metal ions, such as often used melted salt ion exchange and much cheaper and simpler process called electric field assisted dissolution (EFAD), used in our laboratory [1-3]. In EFAD process, thin metal films deposited on glass substrate by electron beam evaporation are subjected to moderately elevated temperature and DC voltages. Resulting current induces several consecutive processes: 1) drifting of naturally present alkali metal ions in glass matrix toward cathode, leaving the subanodic layer depleted of charge carriers; 2) dissolution of thin metal film and 3) subsequent travelling of dissolved metal ions into the subanodic layer. Unfortunately, the doping process is still not completely unveiled. Therefore, the elucidation of the process itself is extremely important. Herein we present ellipsometry based results of the optical properties of Al or Cu EFAD doped glass. Doping with metal ions and depletion from alkali ions are processes that take place simultaneously, but each with its own dynamics. As a consequence, the refractive index in the subsurface layer of the EFAD doped glass changes with the course of the process. Besides this, the refractive index is not constant through the thickness of the affected region since concentration of the dopant metal ions, as well as alkali ions, is not homogeneously distributed.

Keywords: *electric field assisted dissolution, metal thin films*

References :

[1] F. Gonella, E. Cattaruzza, A. Quaranta, S. Ali, N. Argiolas, C. Sada, Solid State Ion. 177 (2006) 3151.
[2] S.Chervinski, I. Reduto, A. Kamenskii, I. S. Mukhin, A. A. Lipovskii, Faraday Discussions 186 (2016) 107-121.
[3] V. Janicki, I. Fabijanić, B. Okorn, P. Dubček, J. Sancho-Parramon, Appl. Phys. Lett. 113, 183508 (2018)

PS-C11

Microstructure and nanoscale piezoelectric properties in $Ba_{0.85}Ca_{0.15}Ti_{0.9}Zr_{0.1}O_3$ (BCTZ) thin films grown by pulsed laser deposition

M. LHEUREUX[1], R. VALOIS[1], M.H. CHAMBRIER[1], F. BLANCHARD[1], P. ROUSSEL[1], J.-F. BLACH[1], A. FERRI[1], A. DA COSTA[1], R. DESFEUX[1] , A. TACHAFINE[2], J.-C. CARRU[2], D. FASQUELLE[2], F. PONCHEL[3], K. DOGHECHE[3], D. REMIENS[3], N. LEMEE[4]

[1]*Univ. Artois, CNRS, Centrale Lille, Univ. Lille, UMR 8181, Unité de Catalyse et Chimie du Solide (UCCS), F-62300 Lens, France*

[2]*Unité de Dynamique et de Structure des Matériaux Moléculaires (UDSMM), Maison de la Recherche Blaise Pascal, Université du Littoral Côte d'Opale, 50 rue Ferdinand Buisson, B.P. 717, 62228 Calais, France*

[3]*Institut d'Electronique, de Microélectronique et de Nanotechnologies, DOAE, UMR 8520 CNRS, Université Polytechnique Hauts-de-France (UPHF), F-59313 Valenciennes, France*

[4]*Laboratoire de Physique de la Matière Condensée (LPMC), UR 2081, Université de Picardie Jules Vernes, Pôle scientifique, 33 rue Saint-Leu, F-80039 Amiens, France*

Email: megane.lheureux@univ-artois.fr

In the frame of an innovative project entitled "Optimization of piezoelectric properties in eco-responsible functional oxides for energy harvesting" and supported by the *Hauts-de-France* Region (France), lead-free $Ba_{0.85}Ca_{0.15}Ti_{0.9}Zr_{0.1}O_3$ (BCTZ) [1] thin films have been successfully grown on (001)-oriented $SrTiO_3$ (STO) substrates by pulsed laser deposition (PLD). Using high-resolution X-Ray diffraction, structural and microstructural properties of the films have been highlighted. As deduced from the 2θ-ω X-Ray patterns, the BCTZ films appear highly (00l)-oriented, showing no secondary orientation or other phase. The narrow rocking-curve, i.e. 0.08° width for 002_{BCTZ} peak, demonstrates the sharp mosaicity of the films as compared to the 0.06° width measured for the 002_{STO} peak of the substrate. Considering the tetragonal structure for the films and taking into consideration the expected (111)-reflection position for measurement, phi-scan recording confirms the existence of the epitaxial growth of BCTZ on STO while reciprocal space map evidences the out-of-plane direction relationship $[001]_{BCTZ}//[001]_{STO}$. While the 2θ-ω X-Ray measurements and advanced Raman spectroscopy analysis are revealing the coexistence of the orthorhombic and tetragonal structures in BCTZ bulk materials, used as target for PLD, further structural measurements need to be carefully performed in the case of thin films to determine the exact structure. In this presentation, reciprocal space maps recorded around specific expected *(or not expected)* nodes, in relation with the symmetry, will be shown to give an account of the precise structure of our films. On the other hand, using the spectroscopic tool of atomic force microscopy which permits to record piezoloops, preliminary results confirm the ferroelectric state (and then piezoelectricity) of our BCTZ films, when grown on semi-conductive Nb-doped (001)-oriented STO substrates. We conclude that these preliminary results are very attractive for the use of such specific oriented lead-free BCTZ thin films for applications in energy harvesting.

Keywords: *BCTZ, Thin film, Microstructure, Nanoscale piezoelectricity, Energy Harvesting*

References :

[1] Rödel, J.; Jo, W.; Seifert, K. T. P.; Anton, E.-M.; Granzow, T. J. Am. Ceram. Soc. 2009, 92 [6], 1153-1177.

PS-C12

Study of the structural, dielectric and ferroelectric properties in $Ba_{0.85}C_{a0.15}Ti_{0.9}Zr_{0.1}O_3$ ceramics

CIOMAGA C.E. [1,2], CURECHERIU L.P. [2], LUKACS A.V. [2], LHEUREUX M. [3], CHAMBRIER M. H. [3], DESFEUX R.[3] AND MITOSERIU L. [2]

[1]*Department of Exact and Natural Sciences, Institute of Interdisciplinary Research, Al. I. Cuza University of Iasi, Carol I, 700506, Iasi, Romania*

[2]*Dielectrics, Ferroelectrics & Multiferroics Group, Faculty of Physics, Al. I. Cuza University Iasi, Carol I, 700506, Iasi Romania*

[3]*Faculty of Sciences Jean Perrin, University d'Artois, Lens, France*

Email: cristina.ciomaga@uaic.ro

Lead-free (Ba,Ca)(Ti,Zr)O_3 ceramics had attracted a broad interest as lead-free piezoelectric materials for application in microelectronic devices. The $Ba_{0.85}Ca_{0.15}Ti_{0.9}Zr_{0.1}O_3$ morphotropic phase boundary (MPB) composition was reported to show enhanced piezo, ferroelectric and tunability properties. This composition being at quadruple point, it is supposed that the maximization of properties is related to its polymorphs' superposition. The large variety of reported properties for the same composition was not fully explained. In various types of samples, the phase composition may change according to the used precursors, synthesis and sintering strategy giving rise to various local compositional and structural heterogeneities, grain sizes, grain boundaries and charge defects. In this work, the $Ba_{0.85}Ca_{0.15}Ti_{0.9}Zr_{0.1}O_3$ ceramics were produced by solid state reaction using conventional ceramic and different grinding ways. We have performed a comparative study at the low and high electric field (dielectric permittivity at different temperature and frequency range, P(E) hysteresis loops and dc-tunability) for prepared BCTZ ceramics with different degree of density. The temperature dependence of the real part of permittivity and dielectric losses at a few frequencies obtained in the investigated BCTZ ceramics present different permittivity value of 1000, and respectively 6800 with the same dielectric losses of about 2%. The switching characteristics revealed a reduction of the coercitivity field from 2.4 to 2 kV/cm, remnant polarization (P_r) from 4.3 to 3.5μC/cm^2 and area, in BCTZ sample 1 and BCTZ sample 2, respectively. The samples show a higher value of saturation polarization (P_s ≅3.5 μC/cm2) and a more tilted loops, with a low rectangularity factor (P_r/P_s), due to the effect of some parameters as local compositional inhomogeneity, local electric field distribution in the materials and the grain size. The effect of electric poling on the structural and piezoelectric properties of the BCTZ samples was analyzed and discussed.

Keywords: *dielectric and ferroelectric properties, structural characterization, piezoelectric response*

Acknowledgements: This work was supported by Romanian Ministry of Research and Innovation grant, CCCDI-UEFISCDI, project no PNIII-P3-3.1-PM-RO-FR-2019-0069.

PS-C13

The role of microstructure on dielectric properties of polymer-based composites: Experiment and modelling

CIOMAGA C.E.[1,2], PADURARIU L.[2], CURECHERIU L.[2], ROTARU A.[3], CARUNTU G.[3] AND MITOSERIU L.[2]

[1]*Department of Exact and Natural Sciences, Institute of Interdisciplinary Research, Al. I. Cuza Univ. of Iasi, Carol I, 700506, Iasi, Romania*

[2]*Dielectrics, Ferroelectrics & Multiferroics Group, Faculty of Physics, "Al. I. Cuza" Univ. of Iasi, 700506 Iasi, Romania*

[3]*Faculty of Electrical Engineering and Computer Science & MANSiD Research Center, Stefan cel Mare University, 720229 Suceava, Romania*

Email: cristina.ciomaga@uaic.ro

Polymer based nanocomposites are in high request both from commercial and scientific points of view due to their improved properties when compared to pure polymers.

The present work is based on the idea that the electrical properties of polymers (e.g. PVDF) matrix may be enhanced by addition of different nanoparticles (e.g. BaTiO3, MWCNTs, and metallic nanoparticles). Thus, it was studied the influence of various filler inclusions and shapes of the particles (such as: cubic, spherical and thread/wire) on the dielectric properties of polymer-based composites. By developing numerical methods based on Finite Element Method, it was demonstrated that the addition of nanoparticles with different shape into polymer matrix play an important role in electrical properties. The dielectric experimental results and the predicted theoretical simulations were compared and discussed in detail. The polymer composites as poly(vinylidene fluoride) (PVDF) with different filler of $BaTiO_3$, MWCNTs and Ag-$BaTiO_3$ particles were prepared by melt blending and solution casting methods. The phase composition was investigated by XRD and FTIR analysis. The microstructural features of the composites were examined by TEM and SEM. The dielectric properties were investigated at room temperature at different frequencies (1Hz - 1MHz) in parallel-plate capacitor geometry by using a frequency response analyzer and in the temperature range (20ºC-160ºC) for frequency range (20Hz-2MHz). In order to study the effect of the shape of the filler particles in a polymer matrix on effective dielectric properties, we have developed numerical methods by using FEM for simulating 3D realistic microstructures, the local electric fields and effective dielectric properties. The experimental investigations and theoretical simulations have confirmed the major role of shape of filler in a polymeric matrix onto the dielectric response. It has shown that the use of cubic-shaped ferroelectric particles is more advantageous for increasing the dielectric response than the use of spherical particles.

Keywords: *polymer composites, dielectric properties, Finite Element Method*

Acknowledgements: This work was financial supported by the Romanian MEN UEFISCDI PN-III-P4-ID-PCCF-2016-0175 grant (HighKDevice)

List of ISyDMA'6 Participants

Last Name	First Name	Country	Reference
ACHKAR	Miriam	France	OP-D01
ACHOUR	Mohammed Essaid	Morocco	OP-VA03, PP-VA05, OP-VC01, OP-VA02
AFEISSA	Saadia	Algeria	PP-VB04
AIT ALI	Mustapha	Morocco	Conf 12, OP-VA9
AL-AKHRAS (AL-OMARI)	Mohamed-Ali	Jordan	Conf 08
ARIBOU	Najoia	Morocco	OP-VA02, PP-VA05
ARIBOU	Zakia	Morocco	OP-VC02
BANYS	Juras	Lithuania	Conf 04, OP-VC06, OP-VC07
BARZINJY	Azeez Abdullah	Iraq	OP-A04
BELDJILALI	Abdeslem	Algeria	PP-VB03
BELHADI	Jamal	France	OP-B04
BEN ACHOUR	Mohamed Aymen	France	OP-D05
BENYOUSSEF	Manal	France	OP-D02
BENZERGA	Ratiba	France	Conf 19, PS-C01, PS-C02, PS-C06
BLAŽEK BREGOVIĆ	Vesna	Croatia	PS-C10
BOBNAR	Vid	Slovenia	Conf 16
BOEV	Victor	Bulgaria	PP-VA06
BOUGHAROUAT	Ali	Algeria	PP-VB01
BOUKNAITIR	Ilham	Morocco	OP-VC01
BOUSBA	Houssem Eddine	Algeria	PP-VB02
BOUSSETA	M.	Morocco	PP-VA10
BREISS	Hanadi	France	OP-C08, PS-C07
BUCELLA	Giacomo	Italy	OP-VA01
CARRU	Jean-Claude	France	PS-C11
CHAHIB	Soukaina	France	OP-D04
CHAIB	Hassan	Morocco	PP-VB05
CHAMBRIER	Marie-Hélène	France	OP-C02
CHO	Yasuo	Japan	Conf 02, OP-C01
CIOMAGA	Cristina Elena	Romania	PS-C12, PS-C13
COSTA	Luis Cadillon	Portugal	Conf 10, OP-VA03, PP-VA05, OP-VC01, OP-VA02
CURECHERIU	Lavinia- Petronela	Romania	OP-A03

DA COSTA	Antonio	France	PS-C08, PS-C09
DESFEUX	Rachel	France	Conf 09
DJEMMAH	Amina	France	OP-B02
DRISSI	Safia	Morocco	PP-VA02
DUBOIS	Frédéric	France	PS-C04, PS-C05
ELMASSI	S.	Morocco	PP-VA09
EL HASNAOUI	Yassine	Morocco	OP-VA04
EL HASNAOUI	Mohamed	Morocco	PP-VA04
EL MANJLI	Faissal	Morocco	OP-VA09
FARHAT	Layla	France	OP-VA08
FASQUELLE	Didier	France	Conf 01, PS-C11
FERRAA	Nouhaila	Morocco	OP-VB03
FERRI	Anthony	France	OP-A02
FONTAINE	Blandine	France	OP-C06
FRECHERO	Marisa A.	Argentina	Conf 06
GARGAR	Zineb	Morocco	OP-VC03
HADOUCH	Youness	Morocco	OP-VA10
HAMOUDA	Messaoud	Algeria	OP-VC05, OP-VC06
HBAB	Abdellah	Morocco	PP-VB06
HNAWI	Salma Kaotar	Morocco	OP-VA08
ILCHEVA	Vania	Bulgaria	PP-VA08
KHEMMOU	Nidal	Morocco	OP-VB01
KINKA	Martynas	Lithuania	PP-VA07
KREMER	Friedrich	Germany	Conf 03
LAKOUADER	Afaak	Morocco	PP-VA01, PP-VA03
LEBLANC	Roger M	USA	Conf 17
LEFEVRE	Gauthier	France	OP-D06
LEMEE	Nathalie	France	Conf 13
LHEUREUX	Mégane	France	PS-C11
MZIOUD	Khaoula	Morocco	OP-VB02
NAYAD	Abdallah	Morocco	OP-VA07
NIOUA	Yassine	Morocco	OP-VA03

PADURARIU	Leontin	Romania	OP-C03
PAL	Bhavna	India	OP-VB04
PALANI	Parthiban	France	OP-C07
PERVAN	Petar	Croatia	PS-C03
PETKOV	Plamen	Bulgaria	Conf 21
PETKOVA	Tamara	Bulgaria	Conf 18, PP-VA08, PP-VA06
PLYUSHCH	Artyom	Lithuania	OP-VC07
POLITOVA	Ekaterina	Russia	OP-VC09
POPOV	Cyril	Germany	Conf 15
OUERIAGLI	Amane	Morocco	OP-VA08, PP-VA05,
OUTZOURHIT	Abdelkader	Morocco	PP-VA09, PP-VA10
SAISSI	Soukaina	Morocco	OP-VC04
SAMIR	Zineb	Morocco	OP-VA05
SHAH	Asmita	France	OP-B03
SHISODIA	Shivani	France	OP-D03
STRICCOLI	Marinella	Italy	Conf 11
SVIRSKAS	Sarunas	Lithuania	OP-VC08
TACHINE	Amina	France	conf 01, OP-VC03, OP-C07, PS-C11
TRIKI	Asma	Tunisia	Conf 20
TRIPATHI	Atul Atul S M	France	OP-D07
TROTSENKO	Vasily	Russia	OP-B01, OP-C04
TSIULYANU	Dumitru	Moldova	Conf 07
VASEASHTA	Ashok	USA	Conf 05
VOISIN	Pierre	France	-
YASSINE	Hassan	France	OP-C05
ZAHID	Marwa	Morocco	OP-VA06
ZDANOWSKA-FRACZEK	Maria	Poland	Conf 14