

Electric Field Enhanced Processing of Advanced Materials III: Complexities and Opportunities

Tomar, Portugal
19-24 March 2023

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Monday, March 20, 2023

07:30 – 08:30 Breakfast

Session I: Overview Presentations

PLEASE NOTE

Please note that talks are limited to <30 min (including 5 – 10 minutes for questions) to make room for a 90 min. round table discussion at the end.

08:30 – 09:00 **The History of Flash Sintering**
Marco Cologna, European Commission, Joint Research Centre (JRC), Germany

09:00– 09:30 **Reactive Flash Sintering** 1
Luis A. Perez-Maqueda, Spanish National Research Council - University of Seville, Spain

09:30 – 10:00 Coffee Break

10:00 – 10:30 **Athermally Enhanced High Temperature Plastic Flow in Zirconia Ceramics under Flash Event** 2
Hidehiro Yoshida, The University of Tokyo, Japan

10:30 – 11:00 **From Electrical Current via Non-Equilibrium n to Frenkel Defects** 3
Dietrich E. Wolf, University of Duisburg-Essen, Germany

11:00 – 11:30 Coffee Break

11:30 – 12:00 **Importance of in-situ Experiments in Understanding External Field Effects during Flash Sintering** 4
Shikhar Krishn Jha, IIT Kanpur, India

12:00 – 12:30 **From Pit Fire to Ultrafast High-Temperature Sintering (UHS): Shared Features of Ultra-Fast Sintering Techniques** 5
Salvatore Grasso, Queen Mary University of London, United Kingdom

13:00 – 14:30 Lunch

14:30 – 15: 00 **Electrical Transitions/Memristors**
Tony West, Sheffield University, United Kingdom

15:00 – 15:30 **Ultra-Fast High Temperature Sintering (UHS) of Strontium Titanate** 6
Martin Bram, Forschungszentrum Juelich GmbH, Germany

15:30 – 16:00 Coffee Break

16:00 – 16:30 **Confluence of Flash and UHS**
Rishi Raj, University of Colorado-Boulder, USA

16:30 – 17:00 Coffee Break

17:00 – 18:30 **Round Table Discussion (all speakers)**

19:30 – 21:00 Dinner

21:00 – 23:00 **Posters and Social Hour**

Tuesday, March 21, 2023

| | | |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 07:30 – 08:30 | Breakfast | |
| | <u>Session 2: Reactive Flash Sintering</u> | |
| 08:30 – 08:50 | Manufacturing <u>David Pearmain</u> , Lucideon Ltd, United Kingdom | |
| 08:50 – 09:10 | Reactive Flash Sintering of High Entropy (Mn_{0.2}Co_{0.2}Ni_{0.2}Cu_{0.2}X_{0.2})Fe₂O₄ (X=Fe, Mg) Spinel Oxides <u>Pedro Sanchez Jimenez</u> , Institute of Materials Science of Seville - CSIC, Spain | 7 |
| 09:10 – 09:30 | Effects of Reactive Flash Sintering on Phase Evolution of Ceramic Materials <u>Lilian M. Jesus</u> , UFSCar, Brazil | 8 |
| 09:30 – 10:00 | Coffee Break | |
| | <u>Session 3: In-Operando Characterization</u> | |
| 10:00 – 10:20 | Structural Changes Induced by Flash in a Single Crystal of Pr₂CuO₄ <u>Dmitry Reznik</u> , University of Colorado-Boulder, USA | 9 |
| 10:20 – 10:40 | Flash Migration Velocity in Bilayers: With and Without Interdiffusion <u>Rishi Raj</u> , University of Colorado-Boulder, USA | |
| 10:40 – 11:00 | Studies of Grain Boundaries by High Resolution TEM <u>Klaus van Benthem</u> , University of California Davis | |
| 11:00 – 11:30 | Coffee Break | |
| | <u>Session 4: SPS/Microwave/UHS</u> | |
| 11:30 – 11:50 | Effect of Microstructural Refinement on Electrical Properties of BST-Based Ceramics Prepared by Spark Plasma Sintering and Spark Plasma Texturing <u>Camila Ribeiro</u> , CICECO - University of Aveiro, Portugal | 10 |
| 11:50 – 12:10 | Ultrafast High-Temperature Sintering of Advanced Ceramics: A Direct Comparison with the State-of-the-Art Techniques <u>Salvatore Grasso</u> , Queen Mary University of London, United Kingdom | 11 |
| 13:00 – 14:30 | Lunch | |
| 14:30 – 14:50 | Evaluating the Microwave Sintering Behaviors of Binder-jetted Additively Manufactured Alumina <u>Bashu Aman</u> , Carnegie Mellon University, USA | 12 |
| | <u>Session 5: Special Materials Systems</u> | |
| 14:50 – 15:10 | Microstructure and Defect Formation in BaTiO₃ Ceramics Obtained by Flash Sintering of Micro and Nanopowders <u>Samuel López Blanco</u> , Universitat Politècnica de Catalunya, Spain | 13 |
| 16:00 – 16:20 | Flash Sintering of Gadolinium-doped Ceria <u>Luca Balice</u> , Forschungszentrum Jülich GmbH, Germany | 14 |
| 16:20 – 17:00 | Coffee Break | |

Tuesday, March 21, 2023 (continued)

| | | |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 17:00 – 17:20 | Field Assisted Sintering Techniques in Recycling NdFeB Magnets <u>Monica Keszler</u> , Forschungszentrum Jülich GmbH, Germany | 15 |
| 17:20 – 17:40 | Effect of Absorbed Power on Densification and Grain Growth during Rapid Microwave Sintering <u>Kirill I. Rybakov</u> , Institute of Applied Physics, Russian Academy of Sciences, Russia | 16 |
| 17:40 – 18:10 | Investigation of the Mechanisms of Flash Sintering in Ceramic Materials <u>Thomas Tsakalakos</u> , Rutgers University, USA | 17 |
| 19:30 – 21:00 | Dinner | |
| 21:00 – 23:00 | Posters and Social Hour | |

Wednesday, March 22, 2023

| | | |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 07:00 – 08:30 | Breakfast | |
| | <u>Session 5: Special Materials Systems (continued)</u> | |
| 08:30 – 08:50 | Flash Assisted Processing of Entropy Stabilized (Mg, Co, Ni, Cu, Zn)O <u>Mohammad Imteyaz Ahmad</u> , Indian Institute of Technology (BHU), India | 18 |
| 08:50 – 09:10 | Investigation and Enhancement in Properties of Copper Converter Slag Residue with Flash Sintering Method <u>Zeynep Çetinkaya</u> , Konya Technical University, Turkey | 19 |
| 09:10 – 09:30 | Flash Sinter-Crystallization: A New Technique for Ultrafast Crystallization of Glasses <u>João Vitor Campos</u> , Universidade Federal de São Carlos, Brazil | 20 |
| 09:30 – 10:10 | Coffee Break | |
| 10:10 – 10:30 | Behind the High Electrical Performance of Flash Sintered Potassium Sodium Niobate Piezoelectric Ceramics <u>Alexander Tkach</u> , University of Aveiro, CICECO-Aveiro Institute of Materials, Portugal | 21 |
| 10:30 – 10:50 | Preliminary Results of Flash Sinter-Crystallization of $\text{Li}_{1.3}\text{Al}_{0.3}\text{Ti}_{0.7}(\text{PO}_4)_3$ for All Solid-State Batteries <u>Ana Candida Rodrigues</u> , Federal University of São Carlos, Brazil | 22 |
| 10:50 – 11:10 | Influence of Fields on Grain Boundary Mobility in Alumina <u>Rachel Marder</u> , Technion – Israel Institute of Technology, Israel | 23 |
| 11:10 – 11:20 | In-situ Generation and Grain Growth of CeO₂ Nanocrystals in AC/DC Electrical Fields <u>Vaclav Tyrpekl</u> , Charles University, Czech Republic | 24 |
| 12:15 – 13:30 | Lunch | |
| 13:50 | Excursion: Meet in hotel lobby | |
| 14:00 | Depart with guides on excursion | |
| 18:00 | Return from excursion | |
| 18:30 | Social hour in Lobby Bar | |
| 19:30 – 21:00 | Dinner | |
| 21:00 – 23:00 | Social Hour | |

Thursday, March 23, 2023

| | | |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 07:30 – 08:30 | Breakfast | |
| | <u>Session 6: Metals</u> | |
| 08:30 – 08:50 | Laser Powder Bed Fusion of Cemented Carbide Geometries Using Tungsten Carbide-Nickel Agglomerated Powder <u>Alexander Gourley</u> , Carnegie Mellon University, USA | 25 |
| 08:50 – 09:10 | MXeene-Based Ceramic Nanocomposites Enabled by Field-Assisted Sintering <u>Maxim Sokol</u> , Tel Aviv University, Israel | 26 |
| 09:10 – 09:40 | Coffee Break | |
| 09:40 – 10:00 | Nanocarbon-Infused Copper Conductors by Electric Field Assisted Processing <u>Uthamalingam Balachandran</u> , University of Colorado-Boulder, USA | 27 |
| 10:00 – 10:20 | Energy Deficit and Defect Formation <u>Jean-Marie Lebrun</u> , St. Gobain, France | |
| 10:20 – 11:20 | OPEN DISCUSSION: Defects: Calorimetry, Characterization, Phonons | |
| 13:00 – 14:30 | Lunch | |
| | <u>Session 7: Defects and Theory/Experiments</u> | |
| 14:30 – 14:50 | Memristors: The Role of Anode Interface Resistance <u>Rishi Raj</u> , University of Colorado-Boulder, USA | |
| 14:50 – 15:10 | Neural Network-Based Simulation Method to Examine Ion Behaviors Under Electric Fields: Application to Ion Migration in Amorphous Li₃PO₄ <u>Koji Shimizu</u> , The University of Tokyo, Japan | 28 |
| 15:10 – 15:30 | Probing the local structure of electroluminescing rutile TiO₂ with neutron diffuse scattering and atomistic modelling <u>Ty Sterling</u> , University of Colorado-Boulder, USA | 29 |
| 15:30 – 15:50 | Role of Native Defects in Field-Assisted Sintering <u>Yoed Tsur</u> , Technion - Israel Institute of Technology, Israel | 30 |
| 16:00 – 16:30 | Coffee Break | |
| 16:30 – 16:50 | First-Principles Design and Discovery of New High-Entropy Materials <u>Liping Yu</u> , University of Maine, USA | 31 |
| 16:50 – 17:10 | Flash Sintering as a Route to Produce Lead-Free Piezoelectric KNN <u>Ana Senos</u> , University of Aveiro, Portugal | 32 |
| 17:10 – 17:30 | Understanding Flash Sintering of Semiconductor Oxide Materials at the Nano- Atomic Scale <u>Fátima Zorro</u> , Instituto Superior Técnico, Portugal | 33 |
| 17:30 – 18:45 | Posters Session | |
| 18:45 – 20:00 | Social hour with piano | |
| 20:00 – 22:00 | Conference Gala Dinner | |

Friday, March 24, 2023

07:30 – 08:30 Breakfast

Session 8: Advanced Methods

08:30 – 08:50 **Touch Free Sintering with Superposition of Magnetic Fields**
Rishi Raj, University of Colorado-Boulder, USA

08:50 – 09:10 **Multi-Phase Flash Sintering: The Next Natural Step in Flash Sintering Evolution** 34
Sandra Molina-Molina, Spanish National Research Council (CSIC), Spain

09:10 – 09:30 **Rapid Densification of Technical Ceramic Coatings using a Precise Controlled Contactless Flash Sintering System** 35
Carolyn Grimley, Lucideon, USA

09:30 – 09:50 **Flash Sintering, a Novel Technique, for Manufacturing Surrogate and Active Nuclear Materials** 36
Gareth Jones, Lucideon Ltd, United Kingdom

09:50 – 10:30 Coffee Break

10:30 – 10:50 **Generating Electrically Conducting Single Crystals of Rutile Titania Through Repetitive Flash Experiments** 37
Devinder Yadav, Indian Institute of Technology Patna, Bihta, India

10:50 – 11:30 **OPEN DISCUSSION: The Future?**

13:00 – 14:30 Lunch and Departures

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An ECI Conference Series

March 19-24, 2023

Tomar, Portugal

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Anat Karlin, Technion - Israel Institute of Technology, Israel
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Eduardo Bellini Ferreira, São Carlos Engineering School (EESC)/University of São Paulo, Brazil
3. **Self-joining of Y-TZP by flash event under an AC electric field** 40
Kohta Nambu, Kyushu University, Japan
4. **Calcium and the elongated grain shape of alumina** 41
Iman Naamne, Technion-Israel Institute of Technology, Israel
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Isabela Reis Lavagnini, University of São Paulo, Brazil
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Jean-Francois Fagnard, University of Liege, Belgium
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Jonathan Mottye, Ben-Gurion University of the Negev, Israel
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Pedro E. Sanchez Jimenez, Instituto de Ciencia de Materiales de Sevilla, Spain
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Pedro Sanchez Jimenez, Institute of Materials Science of Seville - CSIC, Spain
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Philippe Vanderbemden, University of Liege, Belgium
13. **A study on the current-controlled flash sintering experiments on 3YSZ-Ni composites** 50
Pranav Rai, Indian Institute of Technology Patna, India
14. **Electric-field directionality effect during flash joining of metal-ceramic multi-layered structure** 51
Raghav Mundra, Indian Institute of Technology Kanpur, India

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Sabyasachi Panda, Indian Institute of Technology Madras, India
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Samuel López Blanco, Universitat Politècnica de Catalunya, Spain
18. **Flash sintered Al₂O₃-YSZ-Boron composite for tribological applications** 55
Subin Jose and Merbin John, University of Nevada, Reno, USA
19. **WITHDRAWN**
20. **Development of a microcontroller-based phase resolved partial discharge measurement system with application to the monitoring of flash sintering discharge patterns** 56
Thibault Gillis, Université de Liège, Belgium
21. **Insights into the use of Flash Sintering methods to prepare catalytic materials** 57
Xavier Vendrell Villafuela, Universitat de Barcelona, Institut de Nanociència i Nanotecnologia (IN2UB), Spain