ARMS – GRAPHERGIA WORKSHOP AT GRAPHENE WEEK 2026

Scalable Graphene Technologies for Smart Textiles, Wearable Electronics and Next-Generation Supercapacitors

🗓️ Thursday 24 September, 16:05 – 18:20 WEST

Workshop Organisers

- Spyros Yannopoulos, FORTH (sny@iceht.forth.gr)
- Magda Spella, FORTH (spella@iceht.forth.gr)
- Hamed Pourkheirollah, TAU (hamed.pourkheirollah@tuni.fi)
- Matti Mantysalo, TAU (matti.mantysalo@tuni.fi)

Workshop Chairs

- Spyros Yannopoulos, FORTH (GRAPHERGIA)
- Hamed Pourkheirollah, TAU (ARMS)

Funded by the European Union

Workshop Summary

The joint workshop hosted by the ARMS and GRAPHERGIA projects at Graphene Week 2026 will highlight recent advances in scalable graphene technologies for smart textiles, wearables, and next-generation supercapacitors. As EU-funded initiatives within the Graphene Flagship ecosystem, the two projects address complementary aspects of graphene-enabled energy innovation. GRAPHERGIA focuses on sustainable pilot lines for flexible and structural energy-harvesting and storage devices, including smart textile platforms, while ARMS develops eco-friendly micro-flexible and structural supercapacitors based on graphene-rich and graphene-decorated materials, supported by scalable atomic layer deposition technologies. Together, the workshop will showcase how graphene and related materials are enabling energy-autonomous systems through the convergence of advanced materials, scalable manufacturing, and application-driven device integration.

ARMS Project

The ARMS project focuses on the development of eco-friendly supercapacitors by integrating advanced materials and processes. Key highlights include:

- **Materials innovation**: Utilisation of graphene-rich bio-based carbon materials and graphene-decorated carbon fibers to enhance performance.
- **Advanced manufacturing**: Implementation of scalable and cost-effective atomic layer deposition (ALD) technology to produce supercapacitors.
- **Eco-friendly approach**: Commitment to creating environmentally sustainable energy storage solutions with energy densities surpassing 50 Wh/kg, comparable to batteries without compromising on power density, cycle life, or eco-friendliness.
- **Economic impact**: Aiming to establish a new value chain for supercapacitor manufacturing, with a focus on European SMEs as key players.

GRAPHERGIA Project

GRAPHERGIA aims to advance energy harvesting and storage through innovative graphene-based technologies. Key highlights include:

- **Laser-assisted production**: Development of advanced laser-assisted graphene fabrication methods for smart, self-charging textiles.
- **Energy integration**: Seamless integration of energy-harvesting and storage functionalities into textiles and wearable systems.
- **Next-generation batteries**: Advancement of graphene-enabled Li-ion battery technologies with improved performance and sustainability.
- **IoT connectivity**: Support for energy-autonomous devices by sustainably powering smart and connected systems through graphene technology.

This project is supported by the European Union, under Horizon Europe Programme (Grant Agreement n.101120832

Workshop Goals

- **Knowledge exchange**: Provide a platform for researchers, industry experts, and stakeholders to present recent advances in scalable graphene technologies for smart textiles, wearables, and high-performance supercapacitors.

- **Cross-project synergies**: Stimulate interaction between academia, industry, and SMEs by highlighting complementary developments in laser-assisted graphene manufacturing, advanced electrode design, atomic layer deposition, and device integration.

- **Innovation and impact**: Discuss pathways toward the scale-up, validation, and real-world deployment of graphene-enabled energy harvesting and storage technologies.

- **Future directions**: Identify key scientific, technological, and industrial challenges, as well as emerging opportunities, in sustainable energy-autonomous systems based on graphene and related materials.

Plenary Speaker

The plenary talk of the workshop will be delivered by **Dr. Sheng Dai, Professor of Chemistry, Department of Chemistry, University of Tennessee**, Knoxville, TN 37996-1600, USA. The title of his presentation is **"Unconventional Carbon Processing"**.

This presentation highlights a series of unconventional processing strategies that leverage the unique physicochemical properties of molten salts and ionic liquids to transform carbon materials. In particular, a molten salt-based electrochemical graphitisation process is introduced that converts amorphous carbon precursors, including biomass-derived carbons and hard carbons, into highly crystalline graphite at temperatures hundreds of degrees lower than those required for conventional thermal graphitisation. This electrochemical approach dramatically reduces energy consumption while preserving desirable structural features such as porosity and nanostructuring, thereby enabling the scalable production of graphite for battery applications. Beyond graphitisation, molten salts and ionic liquids provide versatile platforms for engineering graphene-based materials. Ionic-liquid-assisted exfoliation enables the direct production of few-layer graphene from natural graphite without aggressive oxidation or reduction treatments, preserving the intrinsic conductivity and structural integrity of graphene. In addition, molten-salt processing can induce controlled heteroatom doping, defect engineering, and nanopore formation within graphene frameworks, producing dense, nitrogen-doped graphene architectures with enhanced ion transport and electrochemical performance. Functionalisation strategies, including fluorination of graphene and graphitic carbons, further demonstrate the ability to tailor electronic structure, defect chemistry, and energy-storage characteristics through controlled chemical modification. Collectively, these examples illustrate how molten salts and ionic liquids can serve as

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powerful reaction media for the synthesis, transformation, and functionalisation of carbon materials. By enabling low-temperature graphitisation, defect and interface engineering, heteroatom incorporation, and scalable graphene production, these unconventional processing routes open new opportunities for manufacturing next-generation carbon materials that support sustainable battery, supercapacitor, and clean-energy technologies.

Conclusion

This joint workshop will highlight the transformative potential of graphene and related materials in shaping the next generation of sustainable energy technologies. By bringing together the complementary expertise of ARMS and GRAPHERGIA, the workshop will showcase advances spanning smart textiles, wearables, scalable graphene manufacturing, and high-performance supercapacitors. Together, the two projects demonstrate how graphene-enabled innovation can accelerate the development of eco-friendly, application-driven energy harvesting and storage solutions for future autonomous devices and systems.

Workshop Programme and Speakers

Time	Speaker and Talk
16:05 – 16:45	**Sheng Dai**, Professor of Chemistry, Department of Chemistry, University of Tennessee, Knoxville, TN 37996-1600, USA. *Unconventional Carbon Processing (Plenary Talk)*
16:45 - 17:10	**Spyros Yannopoulos**, Research Director at Foundation for Research and Technology Hellas (FORTH) and Professor of Chemistry at the University of Patras, Greece. *Laser-Enabled Graphene Integration for Flexible Electronics and Energy Storage*
17:10 - 17:35	**Hamed Pourkheirollah**, Researcher, Tampere University (TAU), Finland. *Atomic Layer Deposition of Metal Oxides on Porous Carbon Electrodes for High-Performance Supercapacitors*
17:35-17:55	**Apurba Ray**, Research Scientist, German Aerospace Center (DLR e.V.), Cologne, Germany. *Powering the Future with Graphene: High-Performance, Flexible Laser-Induced Graphene and Ionic Liquid Gel Electrolyte Micro-Supercapacitors for Wearable Electronics*
17:55-18:15	**Komal Gola**, Researcher, Chalmers University of Technology, Sweden. *Surface Growth of Porous rGO:MXene Composite Electrodes on Carbon Fibers for Structural Supercapacitors*
18:15-18:20	Discussion

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Meet the Speakers

Dr. Sheng Dai - University of Tennessee

Dr. Sheng Dai is currently a Professor of Chemistry at the University of Tennessee, Knoxville (UTK) and also serves as a section head overseeing four research groups at Chemical Sciences Division, Oak Ridge National Laboratory. Dr. Dai's research accomplishments have been recognised with numerous honors, including the 2025 RSC Fray Lecture, the 2020 Max Bredig Award for Ionic Liquids and Molten Salts, the 2019 ACS Award in Separation Science and Technology, the 2018 IMMA Award from the International Mesostructured Materials Association, and nine R&D 100 Awards. In 2022, he was named a DOE Distinguished Scientist Fellow in recognition of his exceptional contributions to U.S. Department of Energy–supported energy research. He is a Fellow of the Materials Research Society, the American Association for the Advancement of Science, and the National Academy of Inventors.

Dr. Spyros Yannopoulos - FORTH and University of Patras

Dr. Spyros Yannopoulos is Professor of Physical Chemistry at the University of Patras and a collaborating researcher at FORTH/ICE-HT, where he leads the Laboratory for Nanotechnology and Advanced Energy Systems. His current research focuses on the rational and scalable synthesis of various 1D and 2D nanomaterials using physical and chemical methods, including laser-assisted fabrication of graphene-based nanomaterials and CVD growth of semiconducting materials. The main target applications include energy conversion and storage, photovoltaics, photocatalytic reactors, and flexible/stretchable electronics. He has published over 180 peer-reviewed journal articles, contributed more than 15 invited chapters to international books, and is co-inventor of three international patents. He currently coordinates two Horizon Europe collaborative projects focused on innovative advanced materials and processes for energy conversion and storage, and has led or participated in more than 30 international research projects. He has presented at over 150 international conferences, including more than 50 invited talks.

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Dr. Hamed Pourkheirollah - University of Tampere

Dr. Hamed Pourkheirollah is a Postdoctoral Research Fellow at Tampere University, Finland, specialising in atomic layer deposition (ALD) of metal oxides on porous carbon materials for high-performance printed supercapacitors. He also serves as the Technical Project Manager of the EU-funded project ARMS (Atomic layer-coated gRaphene electrodes for Micro-flexible and Structural supercapacitors). Dr. Pourkheirollah received his Doctor of Science (D.Sc.) degree from Tampere University through the prestigious Marie Skłodowska-Curie Actions (MSCA) programme. His doctoral research focused on the modeling, analysis, and integration of printed supercapacitors for energy storage and functional applications.

Dr. Apurba Ray - German Aerospace Center (DLR)

Dr. Apurba Ray is currently working as a Research Scientist at Institute for Frontier Materials on Earth and in Space (FM), German Aerospace Center (DLR e.V.) in Cologne. He works diligently as a researcher and stands as one of the lead persons in several European Union (EU)-funded projects, including PHOENIX and GRAPHERGIA, focusing on next-generation electrochemical energy storage devices (Lithium-ion battery and supercapacitors). He earned his PhD in 2019 from Jadavpur University, India, specialising in high-power supercapacitors. His academic excellence has been recognised with the prestigious INSPIRE Scholarship (2008) from the Department of Science and Technology (DST) and a Senior Research Fellowship (2018) from CSIR, Government of India. Following his PhD, he moved to Germany under the competitive DLR-DAAD Postdoctoral Research Fellowship. An active contributor to the scientific community, Dr. Ray has published 47 peer-reviewed research papers and 3 book chapters. His work earned "Best Paper" awards from the journals Molecules (2022) and Batteries (2023). He serves as an Associate Editor for Frontiers in Batteries and Electrochemistry (Supercapacitors section), has acted as a Guest Editor for multiple special issues, and has peer-reviewed over 150 manuscripts for leading international journals. He has also delivered 15 invited and research talks at national and international conferences worldwide.

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Ms. Komal Gola – Chalmers University of Technology

Ms. Komal Gola is a Doctoral researcher at Chalmers University of Technology in Sweden, specialising in the surface growth and functionalisation of carbon-based materials for energy storage applications. Her Ph.D. research is funded by the EU-funded ARMS (Atomic layer-coated gRaphene electrodes for Micro-flexible and Structural supercapacitors) project. Her research focuses on developing functionalised carbon materials including carbon fibers, graphene, MXene. She is also engaged in the fabrication, characterisation, and electrochemical evaluation of supercapacitors to advance next-generation flexible, high-performance energy storage devices.

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