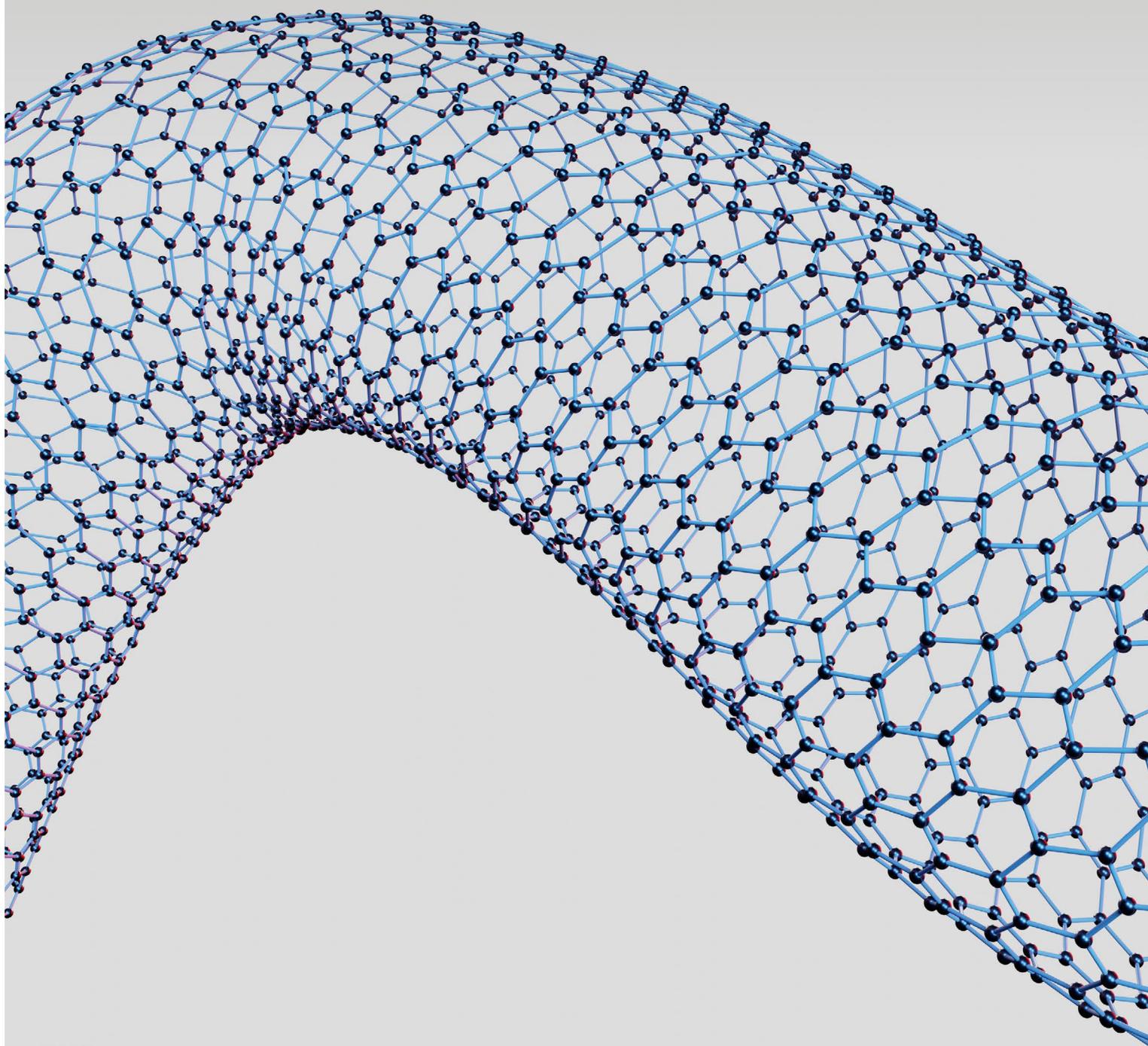


UK-KOREA BILATERAL INTERNATIONAL MEETING

4 – 5 MARCH 2026

Organised by the Royal Society, the Institute of Basic Science
and the Korean Academy of Science and Technology



THE
ROYAL
SOCIETY

ibS 기초과학연구원
Institute for Basic Science

KAST 한국과학기술원
The Korean Academy of Science and Technology

This meeting is part of the Royal Society scientific programme – connecting scientists from around the world in discussions which influence their field and inspire future research opportunities.

The abstracts in this booklet are provided by the presenters and the Royal Society takes no responsibility for their content.

Welcome

Dear participant,

Welcome to the UK-Korea bilateral international meeting 2026 organised by the Royal Society, the Institute for Basic Science (IBS) and the Korean Academy of Science and Technology (KAST) taking place at the Royal Society, London on Wednesday 4 and Thursday 5 March 2026.

The meeting has broadly been divided into two parallel streams: Nanoscience for Medicine, and Ultrastrong and Lightweight Materials. The details of the meeting have been planned by an organising committee made up of:

Nanoscience for Medicine theme:

- Korea Co-chair: Professor Jinwoo Cheon, The Institute for Basic Science (IBS) Center for Nanomedicine
- UK Co-chair: Professor Dame Carol Robinson DBE FMedSci FRSC FRS, University of Oxford
- Korea Junior Co-chair: Professor Dae-Hyeong Kim, Institute for Basic Science, Seoul National University
- UK Junior Co-chair: Dr Maya Miller, University of Oxford, Kavli Institute for Nanoscience

Ultrastrong and Lightweight Materials:

- Korea Co-chair: Professor Rodney S Ruoff, The Center for Multidimensional Carbon Materials, The Institute for Basic Science (IBS)
- UK Co-chair: Professor Philip Withers FREng FRS, University of Manchester
- UK Co-chair: Professor Robert Young FREng FRS, University of Manchester
- Korea Junior Co-chair: Professor Seung Min Jane Han, The Korea Advanced Institute of Science and Technology
- UK Junior Co-chair: Dr Dimitrios Papageorgiou, Queen Mary University of London

The meeting is designed to bring together outstanding scientists in an environment which encourages informal networking and discussion. The objective is to build on and strengthen scientific ties between researchers from Korea and the UK, and to provide opportunities for peer-on-peer scientific discussion on areas of scientific strength and where further collaboration might be possible.

We appreciate your time and hope that this meeting proves insightful, enjoyable and collaborative.

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Programme

Wednesday 4 March 2026

08:30	Registration and arrival refreshments	
08:50	Welcome remarks Sir David Baulcombe FMedSci FRS, Vice President and Biological Secretary, The Royal Society Professor Sung-Jin Kim, Executive Vice President, The Korean Academy of Science and Technology (KAST) Shibo Shim, Acting Vice President, The Institute for Basic Science (IBS)	
09:05	Opening session	
09:30	<i>5 minutes to allow speakers to move into separate meeting rooms</i>	
	Nanoscience for Medicine Venue: Kohn Centre	Ultrastrong and Lightweight Materials Venue: Conference room
	Co-chair opening session: (Chair: Dae-Hyeong Kim)	Co-chair opening session: 2D Materials (Chair: Dimitrios Papageorgiou)
09:35	Jinwoo Cheon (Korea)	09:35 Rodney S Ruoff (Korea)
10:05	Carol Robinson FRS (UK)	10:05 Robert Young FRS (UK)
10:35	Discussion	10:35 Discussion
10:55	Break	
	Session 1: Synthetic cells (Chair: Carol Robinson FRS)	Session 1: Novel architectures (Chair: Robert Young FRS)
11:25	Yuval Elani (UK)	11:25 Taek-Soo Kim (Korea)
11:55	Minsuk Kwak (Korea)	11:55
12:25	Discussion	12:25 Discussion
12:45	Group photograph and Lunch	
	Session 2: Materials for delivery and therapeutics (Chair: Maya Miller)	Session 2: Synthesis of nanostructures (Chair: Robert Young FRS)
13:45	Mikyung Shin (Korea)	13:45 Won Kyung Seong (Korea)
14:15	Adrian Najer (UK)	14:15 Milo Shaffer (UK)
14:45	Discussion	14:45 Discussion
15:05	Break	
	Session 3: Nanoscience for Medicine Keynote session (Chair: Jinwoo Cheon)	Session 3: Computational aspects (Chair: Rodney S Ruoff)
15:30	George Malliaras FRS (UK)	15:30 Ill Ryu (Korea)
	Session 4: Nanobiomaterials for sensing/imaging (Chair: Dae-Hyeong Kim)	16:00 Nicola Pugno (UK)
		16:30 Discussion
16:15	Michael Booth (UK)	
16:45	Chulhong Kim (Korea)	17:00 Close of day 1 discussion
17:15	Discussion	
17:30	Close of meeting day 1	
17:30 - 19:00	Drinks and dinner reception at the Royal Society with Library artefacts show and tells	

Thursday 5 March 2026

08:30	Arrival refreshments	
08:45	The Royal Society Grants and Publishing presentations	
09:00	Plenary session: Taeghwan Hyeon FRSC (Korea)	
09:45	<i>5 minutes to allow speakers to move into separate meeting rooms</i>	
	Nanoscience for Medicine Venue: Wolfson room 3	Ultrastrong and Lightweight Materials Venue: Kohn Centre
	Session 5: AI driven nanobiomaterials (Chair: Maya Miller)	Session 4: Layered structures (Chair: Seung Min Jane Han)
09:50	Íris Luz Batalha (UK)	09:50 Florian Bouville (UK)
10:20	Sunghoon Kwon (Korea)	10:20 Seunghwa Ryu (Korea)
10:50	Discussion	10:50 Discussion
11:10	Break	
	Session 6: AI and digital medicine (Chair: Dae-Hyeong Kim)	Session 5: Interfaces (Chair: Dimitrios Papageorgiou)
11:30	Namshik Han (Korea)	11:30 Gi-Dong Sim (Korea)
12:00	Gavin Jell (UK)	12:00 Manish Tiwari (UK)
12:30	Discussion	12:30 Discussion
12:50	Lunch	
	Session 7: Soft Nano Materials (Chair: Carol Robinson FRS)	Session 6: Multifunctional nanocomposites (Chair: Rod Ruoff)
13:50	Maya Miller (UK)	13:50 Dimitrios Papageorgiou (UK)
14:20	Liyun Ma (UK)	14:20 Seung Min Jane Han (Korea)
14:50	Discussion	14:50 Discussion
15:10	Break	
	Session 8: Neural and cardiac interfaces (Chair: Jinwoo Cheon)	Session 7: Graphene related aspects (Chair: Seung Min Jane Han)
15:30	Dae-Hyeong Kim (Korea)	15:30 Ian Kinloch (UK)
16:00	Andrew Jackson (UK)	16:00 Rodney S Ruoff on behalf of Anirban Kundu (Korea)
16:30	Discussion	16:30 Discussion
16:50	All in one meeting room	
16:55	Closing remarks	
17:00	End of meeting	

The Royal Society

The Royal Society is a self-governing Fellowship of many of the world's most distinguished scientists drawn from all areas of science, engineering, and medicine. The Society's fundamental purpose, as it has been since its foundation in 1660, is to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity.

The Society's strategic priorities emphasise its commitment to the highest quality science, to curiosity-driven research, and to the development and use of science for the benefit of society. These priorities are:

- The Fellowship, Foreign Membership and beyond
- Influencing
- Research system and culture
- Science and society
- Corporate and governance

For more information, visit: royalsociety.org

The Korean Academy of Science and Technology (KAST)

Overview

The Korean Academy of Science and Technology (KAST) is Korea's leading academic institution representing distinguished scholars in science and engineering. Established in 1994 as an independent, nongovernmental organization, KAST serves as an authoritative body dedicated to advancing science and technology and strengthening national competitiveness.

In March 2016, KAST was designated as the competent authority for the "Project on the Honorable Treatment and Support for Persons of Distinguished Service to Science and Technology," reinforcing its national role in recognizing scientific excellence.

Membership

KAST membership is composed of Korea's most eminent scientists and engineers, elected through a rigorous peer-review process. Election to membership is regarded as one of the highest academic honors in Korea.

The Academy comprises Fellows, Fellows Emeritus, Young KAST Members, Young KAST Alumni and Foreign Members. Its membership spans a broad range of disciplines, including natural sciences, engineering, biomedical sciences, and emerging interdisciplinary fields.

Beyond academic distinction, members actively contribute to national policy advisory activities, strategic research initiatives, international cooperation and science outreach. Through this collective expertise, KAST functions as a national intellectual platform supporting evidence-based policymaking and global scientific engagement.

Core Activities

- **Policy Research and Consultation:** Providing independent and evidence-based recommendations on key science and technology issues.
- **International Cooperation:** Promoting global partnerships and science diplomacy through collaboration with overseas academies and international organizations.
- **Awards and Recognition:** Operating a comprehensive award system supporting scientists throughout their career life cycle and promoting the pride and morale of the scientific community.
- **Science Promotion:** Enhancing public understanding and appreciation of science through outreach and engagement programs.

The Institute for Basic Science (IBS)

Founded in 2011 by the Government of the Republic of Korea, the Institute for Basic Science (IBS) is a national research institution dedicated to fundamental science. IBS was established to push the frontiers of knowledge through ambitious, curiosity-driven research that deepens our understanding of nature and contributes to the advancement of humanity.

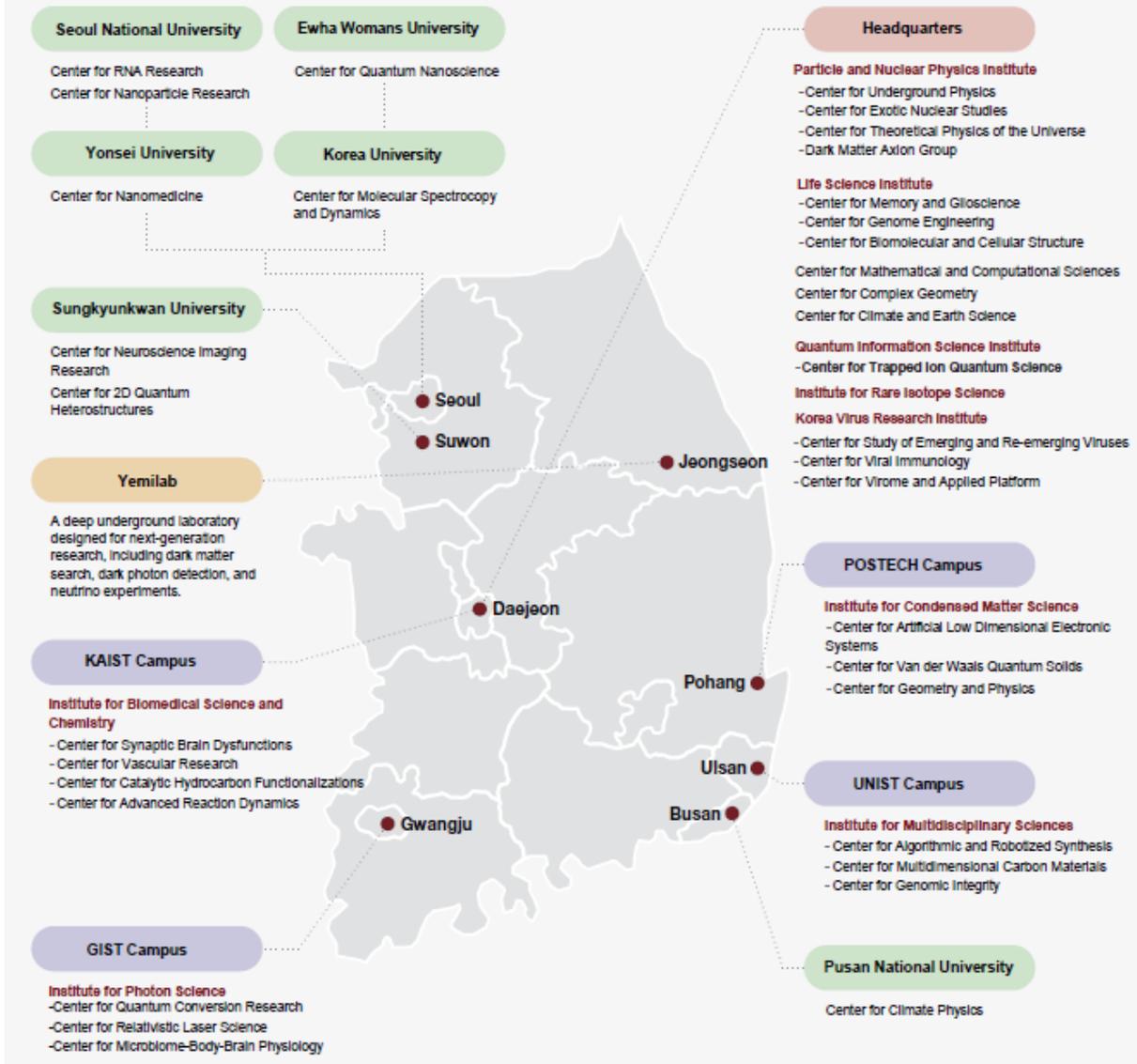
A defining feature of IBS is its long-term, performance-based research model. IBS Research Centers are supported through sustained government funding, enabling scientists to pursue fundamental questions without the need to submit competitive grant proposals for core research activities. Directors and Chief Investigators are selected through a rigorous international peer-review process and are granted substantial autonomy in defining research agendas and allocating resources. Continued support is contingent upon regular international evaluations, ensuring that stability is paired with accountability and scientific excellence.

Large-scale research infrastructure forms a central pillar of IBS. The institute develops and operates major national facilities serving both domestic and international scientific communities. These include RAON, a next-generation heavy-ion accelerator complex designed to explore the origins of elements and the fundamental structure of matter, and Yemilab, an underground laboratory dedicated to astroparticle physics and rare-event experiments. These platforms provide world-class experimental environments that enable transformative research in nuclear physics, cosmology, and related fields.

International collaboration is central to the IBS mission. Through initiatives such as IBS Partner Labs and Global Research Centers, the institute establishes strategic partnerships with leading universities and research organizations worldwide. These programs facilitate collaborative research, and shared access to infrastructure, fostering sustained collaboration beyond individual projects. IBS actively participates in global networks, strengthening cross-border cooperation in the pursuit of scientific excellence.

Headquartered in Daejeon, the nation's central science hub, IBS extends its research network across the nation's leading universities, bringing together outstanding scientists at all career stages. By combining stable public investment, large-scale infrastructure, and deep international engagement, IBS seeks to generate the foundational knowledge that will shape the future of science.

IBS Research Centers



Organising Committee Co-chairs

Nanoscience for Medicine Co-chairs



Professor Jinwoo Cheon

The Institute for Basic Science (IBS) Center for Nanomedicine, Korea

Jinwoo Cheon is the Founding Director of the Institute for Basic Science (IBS) Center for Nanomedicine, the Max-Planck Yonsei IBS Center, and the HG Underwood Professor in the Department of Chemistry at Yonsei University. Esteemed for his expertise in inorganic chemistry, he is a leading authority in nanomaterials chemistry and the use of nanoscale probes for imaging and activation of biological systems.

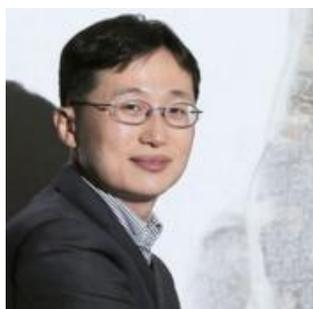
He has been recognised with awards including the NAS-K Prize, Humboldt Research Award, Ho-Am Prize. He currently serves as an Associate Editor for the Journal of the American Chemical Society (JACS).



Professor Dame Carol Robinson DBE FMedSci FRSC FRS University of Oxford, UK

Carol Robinson is the Dr Lee's Professor of Chemistry at the University of Oxford and is the Founder Director of Oxford's Kavli Institute for Nanoscience Discovery. She is recognised for establishing mass spectrometry as a viable technology to study the structure and function of proteins. Carol graduated from the Royal Society of Chemistry in 1979 and completed her PhD at Cambridge University. After a career break of eight years to focus on her family, she became Professor of Mass Spectrometry at Cambridge, returning to Oxford in 2009 to take up her current position. In 2016, she co-founded OMass Therapeutics (OMass.com) with a number of postdoctoral research associates from her laboratory.

Her work has attracted numerous awards including the 2022 Benjamin Franklin Medal in Chemistry, the 2022 Louis Jeantet Prize for Medicine, and most recently the 2023 ASMS John B Fenn Award for a Distinguished Contribution in Mass Spectrometry, and election to the American Philosophical Society. Carol is the former President of the Royal Society of Chemistry, a Foreign Associate of the National Academy of Sciences USA and an International Honorary Member of the American Academy of Arts and Sciences. She was appointed DBE in 2013 for services to science and industry.



Professor Dae-Hyeong Kim

Institute for Basic Science, Seoul National University, Korea

Dae-Hyeong Kim obtained his BS and MS degree in Chemical Engineering from Seoul National University, Korea, in 2000 and 2002, respectively. He received his PhD degree in Materials Science and Engineering from University of Illinois at Urbana Champaign in 2009. From 2009 to 2011, he was a post-doctoral research associate at University of Illinois. He joined Seoul National University in 2011 and is currently a professor in School of Chemical and Biological Engineering of Seoul National University. He has been serving as an associate director of Center for Nanoparticle Research of Institute for Basic Science (IBS) from 2017. He is a fellow of National Academy of Engineering of Korea (2026-present) and Fellow of American Institute of Medical and Biological Engineering (2025-present). He has been recognised as a highly cited researcher by Clarivate Analytics in 2018-2025. He has served as the editors and editorial board members in multiple journals, including the Deputy Editor of Science Advances (2025-present).



Dr Maya Miller

University of Oxford, Kavli Institute for Nanoscience, UK

Dr Miller completed her PhD in bioinorganic chemistry under the supervision of Professor Edit Tshuva, where her research focused on the design and study of titanium-based compounds for cancer therapy. During Maya's doctoral training, she also developed a strong interest in genomic evolution and gained hands-on experience with bioinformatic tools. Seeking to broaden her research perspective, Maya moved to the UK to pursue international research opportunities. She joined the laboratory of Carol Robinson, where she worked on the native biochemical and mass spectrometric characterisation of proteins associated with pancreatic ductal adenocarcinoma (PDAC). Maya subsequently joined the group of Molly Stevens as a Marie Curie Fellow, where her research bridges biomaterials science and native mass spectrometry, integrating chemical biology with advanced analytical techniques.

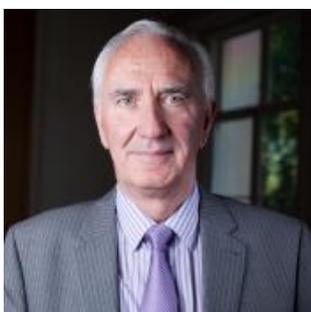
Ultrastrong and Lightweight Materials Co-chairs



Professor Rodney S Ruoff

The Center for Multidimensional Carbon Materials, The Institute for Basic Science (IBS), Korea

Rodney S "Rod" Ruoff is an American physical chemist and nanoscience researcher. He is one of the world experts on carbon materials including carbon nanostructures such as fullerenes, nanotubes, graphene, diamond, and has had pioneering discoveries on such materials and others. Ruoff received his BS in chemistry from the University of Texas at Austin (1981) and his PhD in chemical physics at the University of Illinois-Urbana (1988). After a Fulbright Fellowship at the MPI fuer Stroemungsforschung in Goettingen, Germany (1989) and postdoctoral work at the IBM T J Watson Research Center (1990–91), Ruoff became a staff scientist in the Molecular Physics Laboratory at SRI International (1991–1996). He is currently UNIST Distinguished Professor at the Ulsan National Institute of Science and Technology (UNIST), and the director of the Center for Multidimensional Carbon Materials, an Institute for Basic Science Center located at UNIST.



Professor Robert Young FEng FRS

University of Manchester, UK

Professor Young was the founding Head of the School of Materials in the University of Manchester in 2004, which is now the largest university materials department in the UK. He is a Fellow of Royal Society (2013), Royal Academy of Engineering (2006) and Academy of Europe (2015). He has introduced a number of revolutionary techniques that have given a completely new insight into the micromechanics of deformation in polymers and composites. In particular, he pioneered the use of Raman spectroscopy for the analysis of deformation processes that take place at the molecular level in graphene and other 2D materials. His contribution in research has been recognised through numerous invitations to give Plenary and Keynote lectures at International Conferences and through the awards of the Griffith Medal (2002), Leslie Holliday Prize (2011), Swinburne Medal and Prize (2012) and Platinum Medal (2019) from the Institute of Materials, Minerals and Mining.



Professor Philip Withers FEng FRS

Henry Royce Institute, University of Manchester, UK

Professor Withers is the first Regius Professor of Materials. His research focusses on imaging, modelling and understanding the behaviour of engineering materials in real time and 3D often in situ under demanding environments. To this end he has pioneered the use of synchrotron and lab. X-ray CT and combined this with information from electron and neutron beams to shine a light on their behaviour. Much of his work has been directed towards materials for the aerospace and energy generation industries including high strength Al, Ti and Ni alloys, as well as composite materials. In 2008 he set up the Henry Moseley X-ray Imaging Facility which was awarded the Queen's Anniversary Prize in 2014 for innovation, impact and excellence.



Professor Seung Min Jane Han

The Korea Advanced Institute of Science and Technology, Korea

Seung Min J Han is a Professor in the Department of Materials Science and Engineering at Korea Advanced Institute of Science and Technology. She obtained her PhD in Materials Science and Engineering at Stanford University in 2006, and served as an Acting Assistant Professor at Stanford University before joining KAIST in 2010. Her research group focuses on understanding the mechanical behaviour of materials at the nanoscale with an emphasis on the development of nanocomposites for high-strength, lightweight structural applications. She served as a meeting chair for the 2021 Spring MRS meeting, a chair of MRS Bulletin editorial board and also a board member of Electronic Materials Letters. She is a member of the Young Korean Academy of Sciences in Korea, a recipient of Korean Ministry of Science and ICT Award in Nanomaterials Research, Young Investigator Award of Korean Institute of Metals and Materials.



Dr Dimitrios Papageorgiou

Queen Mary University of London, UK

Dimitrios Papageorgiou is a Reader (Associate Professor) in Functional Materials at Queen Mary University of London, working at the intersection of polymer engineering, nanocomposites, and sustainable electronic materials. His work spans the design of functional polymers and composites with engineered structure–property relationships, from molecular interactions to device-relevant performance. A particular emphasis is placed on reinforcement mechanisms, linking nanoscale and interfacial physics to macroscopic performance and long-term durability. He is also developing sustainable electronics platforms based on natural biopolymers and recyclable device architectures, targeting multifunctionality, low-impact manufacturing and end-of-life separability. He has published extensively in high-impact journals and his contributions have been recognised through multiple awards, including the Rosenhain Medal (2022) and the Composites Award (2024) from IOM3.

Meeting day 1

Wednesday 4 March 2026

Welcome and introduction



Sir David Baulcombe FMedSci FRS

Biological Secretary and Vice President, the Royal Society, UK

David Baulcombe is a plant molecular biologist with an interest in disease resistance. He and his group discovered small RNA and various protein components of an RNA silencing system that protects plants against viruses and affects patterns of plant gene expression.

David's work has been recognised by awards including the Sir Hans Krebs Medal of the Federation of European Biochemical Societies (2021), the Mendel Medal (2017) of the Genetics Society. He received the Gruber Genetics Prize (2014), the Balzan Prize (2012) (for epigenetics), the Wolf Prize for Agriculture (2010) the Albert Lasker Award for Basic Medical Research (2008) and a Royal Medal (2006) of the Royal Society. He is an International Member of the National Academy of Sciences (USA) (elected 2005) and was made a Knight Bachelor in 2009. Since 2007 he is Professor of Botany (Regius since 2012) (now Emeritus) in Cambridge and he was a Royal Society Research Professor (2007-2022).



Professor Sung-Jin Kim

Executive Vice-President, the Korean Academy of Science and Technology, Korea

Dr Sung-Jin Kim is a prominent authority in Chemistry and Nanoscience. After receiving her PhD in Physical Chemistry from Iowa State University in 1989, she served as a professor at Ewha Womans University for over 30 years, establishing herself as a pioneer in nanomaterials research. She has published more than 320 papers in prestigious SCI international journals, including Nano Letters and JACS, and holds 18 patents.

Her excellence in research was recognized with the Order of Science and Technology Merit (First Class, Changjo Medal) in 2020, South Korea's highest scientific honor. She has also received the Academic Excellence Award from the Korean Chemical Society (KCS) and the Minister's Award for her contributions to science.

Dr Kim has held various leadership positions, including Dean of the College of Natural Sciences at Ewha Womans University and Board Member of the National Research Council of Science and Technology (NST). Currently, she serves as the Executive Vice President of the Korean Academy of Science and Technology (KAST), representing the nation's top scholars.



Shibo Shim

Acting Vice President, the Institute for Basic Science, Korea

Shibo Shim is the Acting Vice President and Head of Planning & External Affairs at the Institute for Basic Science (IBS), Korea. Since joining the institute in 2012, he has held key leadership positions, including Chief Communications Officer and Head of the Research Services Division.

With over 25 years of experience in both media and research administration, he has been instrumental in shaping the strategic direction and external

relations of IBS. His expertise in communication and policy planning has played a vital role in enhancing the institutional growth and public engagement of IBS. Before his career at IBS, he served for 15 years as a Staff Reporter at the Maeil Business Newspaper, South Korea's leading economic daily, covering science and technology.

Shim holds an MS in Business Administration from Sejong University and a Bachelor of Business Administration from Korea University. He also served as a Visiting Researcher at Syracuse University in the United States

Nanoscience for Medicine

Co-chair opening session



Chair: Professor Dae-Hyeong Kim

Institute for Basic Science, Seoul National University, Korea



Professor Jinwoo Cheon

The Institute for Basic Science (IBS) Center for Nanomedicine, Korea

Nano for Medicine

Nanotechnology has been an essential concept and tool for seeing and understanding biological systems. Such tiny tools are now making unbelievable breakthroughs in future medicine, ranging from imaging and monitoring biological processes to designing and delivering therapeutic cargoes to disease sites in the skin and deep tissues, such as the brain and heart, with unprecedented precision and accuracy. Until recently, however, seamless molecular-level interfaces between nanoscale materials/devices and biological systems have been difficult to achieve in reality. We will observe the latest developments and amazing accomplishments from UK and Korean speakers in the session “Nano for Medicine”. I will briefly outline the session.

Then I will briefly discuss my research on “designer nanomachines” with mechanical functions at nanoscale precision for next-generation biomedical sciences. In this talk, I will discuss “magneto-mechanical nanoparticles” as core platform materials and tools for a variety of functionalities such as targeting and signaling of cells and live animals in a selective and efficient way. Some of these nanomachines are composed of Au cages with magnetic engines and DNA clutches for programmable mechanical force generation. These tools serve as modulators of neurons via “magneto-mechanical-genetics (MMG)” for therapeutic and motion/behavior control of live animals.



Professor Dame Carol Robinson DBE FMedSci FRSC FRS

University of Oxford, UK

Nanoscale Lipid–Proteome–Drug Interactions in Native Membranes

Understanding the interplay among lipids, proteins, and drugs at the molecular level remains a central challenge in nanoscale drug discovery. Here, we develop mass spectrometry methods that eject proteins directly from membrane vesicles, providing a detailed molecular snapshot of the dynamic and heterogeneous cellular milieu within retina membranes and the intradiscal fraction. By enabling the sequencing of proteins and their proteoforms in this native context, we can directly assess individual drug-binding events at the single-proteoform level inside this endogenous environment. We anticipate that advances in top-down sequencing from native membranes and the ability to define multiple lipidated states and proteoforms will markedly enhance our capacity to discover and optimize therapeutics in increasingly complex native tissue settings.

Session 1: Synthetic cells



Chair: Professor Dame Carol Robinson DBE FMedSci FRSC FRS

University of Oxford, UK



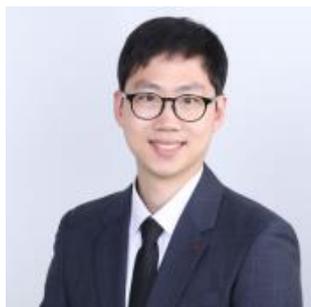
Dr Yuval Elani

Imperial College London, UK

Dr Yuval Elani is a UKRI Future Leaders Fellow and Reader in the Department of Chemical Engineering at Imperial College London. Yuval studied Natural Sciences as an undergraduate (Cambridge, 2009) followed by a PhD in the Institute of Chemical Biology (Chemistry, Imperial College, 2015). After his PhD he held a series of fellowships working on various topics in biochemical engineering. He leads a diverse group of c. 25 researchers working on frontier research in biotechnology. His current research interests include biohybrid systems, synthetic cells, and autonomous laboratories for biomembrane design and discovery.

Microfluidics, automation, and engineered biomembranes as enabling technologies in synthetic cell design

Synthetic cells (SynCells) are bioinspired micromachines constructed from molecular building blocks, mimicking the form and function of biological cells. Despite their promise, SynCells are structurally simplistic, primarily consisting of spherical liposomes, unlike their biological counterparts which are highly compartmentalised. Given that form and function are intertwined, this lack of architectural complexity restricts the development of more sophisticated behaviours. In this talk, I will discuss our recent efforts to overcome these limitations by employing microfluidic assembly lines for SynCell production, enabling the creation of a wide repertoire of SynCell architectures. We harness this increased structural complexity to create a new generation of SynCells with biomimetic behaviours, most notably those capable of detecting external stimuli (including as temperature, light, and magnetic fields) and initiating coordinating biochemical responses through quorum sensing. Additionally, we have recently expanded our toolkit to access the nano regime by using automated approaches to generate and screen lipid libraries. Together with rational design, this enables us to construct nano organelles for multi stage release of different payloads at defined time points, as well as to develop attolitre bioreactors for in situ biochemical synthesis.



Professor Minsuk Kwak

Yonsei University, IBS Center for Nanomedicine, Korea

Minsuk Kwak, PhD, is an Assistant Professor in the Department of Nano-Biomedical Engineering at Yonsei University and serves as the Deputy Director of the Max Planck – Yonsei IBS Center for Nanomedicine. He earned his BS in Bioengineering from Rice University and PhD in Biomedical Engineering from Yale University (advisor: Rong Fan). He carried out his postdoctoral research as a Life Science Research Foundation (LSRF) Fellow

at the University of California, San Francisco (advisor: Young-wook Jun). His research resides at the intersection of cell biology, synthetic biology, and nanoscience, focusing on the development of novel biotechnologies for wireless and precision deep-tissue control of cellular signaling, functions, and fates towards next-generation neuroscience and immunology. He received numerous awards, including the Young Scientist Excellency Grant (National Research Foundation of Korea), the LSRF Postdoctoral Research Fellowship, and Edward L. Barlow Fellowship (Yale U).

Magnetogenetics for remote, wireless deep-brain modulation and therapy

Tools capable of probing and regulating mechanical cell signaling with spatiotemporal precision remain elusive. We have developed a nanomaterial-based magneto-mechanical genetics toolbox for remote, wireless, and spatiotemporal control of cell signaling both in vitro and in vivo animal models. Torque force generated by the nanomagnetic force actuators activate mechanosensitive ion channels, such as Piezo1, genetically encoded in defined cell types and achieves wireless and on-demand neuronal activation in specific neuronal populations at a long distance (>1 meter). We have successfully developed the strategy for the cell-type specific magnetic stimulation or inhibition of deep brain circuitry in freely behaving animals. Wireless magneto-mechanical-genetics achieves robust and reversible activation of neuronal responses, as demonstrated in multiple behavior models, such as bidirectional feeding control, social interactions, and parental behaviors. We have also developed nano-magnetic switches for remote, wireless, spatiotemporal control of CAR T cell activity in deep-tissue to prevent T cell exhaustion, enhance therapeutic efficacy and mitigate neurotoxicity. Nano-magnetogenetics has the potential to open new opportunities for studying neural circuits underlying high-order brain functions including cognition, emotion, and social behaviors in live animals, and also remote, non-invasive, and effective CAR T cell therapy against solid tumors.

Session 2: Materials for delivery and therapeutics



Chair: Dr Maya Miller

University of Oxford, Kavli Institute for Nanoscience, UK



Professor Mikyung Shin

Sungkyunkwan University, Korea

Dr Mikyung Shin is an associate professor in the Department of Biomedical Engineering at Sungkyunkwan University in South Korea. She received her PhD at the Korea Advanced Institute of Science and Technology (KAIST) and completed her postdoctoral research at the University of Pennsylvania. Her research focuses on tissue-adhesive and soft biomaterials engineering for efficient tissue regeneration and biotic-to-abiotic interfacing.

Advanced Biomedical Hydrogels for Peripheral Nerve and Muscle Tissue Regeneration Therapy

Tissue-adhesive biomaterials have emerged as a promising solution for enhancing tissue repair and local drug delivery due to their biocompatibility, tunable mechanical properties, and resistance to delamination on wet tissues. For effective regeneration of peripheral nerve and muscle tissues, which require high elasticity, controlling interfaces with tissue-mimetic hydrogels is crucial for restoring motor function and sensory perception after traumatic injury. This study introduces various hydrogel interfaces with strong adhesiveness to nerve and muscle tissues and electrical conductivity, which effectively promote axon and myofiber growth. The adhesive properties allow for stable attachment without the need for sutures or invasive fixation, reducing complications. Furthermore, combining these conductive, adhesive hydrogels with self-healable, stretchable electronics enables the development of an injectable tissue prosthesis, facilitating closed-loop robot-assisted rehabilitation. Challenges such as long-term stability, mechanical strength, and immune response are discussed, along with future directions for optimizing hydrogel-based therapies in clinical applications.



Dr Adrian Najer

Imperial College London, UK

Adrian Najer is currently an Assistant Professor in Biomaterials at the Department of Materials at Imperial College London, UK. He received his PhD in Nanosciences from the University of Basel, CH, in collaboration with the Swiss Tropical and Public Health Institute (Swiss TPH). He then researched as a postdoctoral fellow at Imperial College London in the groups of Professor Dame Molly Stevens and Professor Jake Baum before holding a Lecturer position at King's College London. His research focuses on developing antipathogenic nanomedicines for global health applications, synthetic cells, point-of-care diagnostics for infectious diseases, and studying nanoparticle heterogeneity and functionality in complex biological environments using single-particle sensitive analysis techniques.

Nanomedicines and nanodiagnostics for parasites, viruses, and bacteria

Infectious diseases caused by parasites, viruses, and bacteria pose an immense burden on global health. The COVID-19 pandemic is a recent reminder of the devastating effects of any new viral disease, especially in the absence of broadly applicable antiviral therapies. Protozoan parasites are equally impactful human pathogens, causing diseases like malaria, trypanosomiasis, leishmaniasis and cryptosporidiosis. We have designed broad-spectrum heparan sulphate mimicking polymer and polymer-lipid hybrid nanoparticle systems that function by directly binding to extracellular viruses and protozoans, hindering host cell infection. These nanomedicines also inhibit interaction of malaria parasite-infected cells with endothelial cells, which could represent a potential treatment for severe malaria. To optimise nanomedicines towards clinical translation, advanced nanomaterial characterisation techniques with single-particle sensitivity were employed, including fluorescence correlation spectroscopy (FCS) to observe protein fouling and single particle automated Raman trapping analysis (SPARTA) to describe the inherent heterogeneity of the nanomedical formulations. We further developed two nanodiagnostic approaches to aim at detecting malaria transmission competency and bacterial implant infection, respectively. Innovative nanomedicines and nanodiagnostics represent exciting platforms towards urgently needed treatments and detection capabilities for infectious diseases.

Session 3: Nanoscience for Medicine Keynote session



Chair: Professor Jinwoo Cheon

The Institute for Basic Science (IBS) Center for Nanomedicine, Korea



Professor George Malliaras FRS

University of Cambridge, UK

George Malliaras is the Prince Philip Professor of Technology at the University of Cambridge (UK) and serves as Director of the Institute for Biomedical Innovation. He received a BS from the Aristotle University (Greece), a PhD from the University of Groningen (the Netherlands) and taught at Cornell University (USA) and at the School of Mines of St. Etienne (France) before joining Cambridge. He is a Fellow of the Royal Society, Materials Research Society, European Academy of Sciences and Academia Europaea, and an honorary doctor of the University of Linköping.

Reading the Brain and Body: New Frontiers in Surface Electrophysiology

Our ability to listen to the body's electrical activity is improving at a remarkable pace. Novel recording technologies now let us capture the brain's complex signals through miniaturised, flexible grids placed on its surface, while equally sophisticated skin mounted sensors can track subtle physiological changes during daily life. Together, these approaches paint a richer picture of how our nervous system communicates and adapts. Applying the same ideas to the spinal cord and peripheral nerves led to the development of gentle surface electrodes that can both record and stimulate activity with surprising accuracy. Such systems can already predict how we move or even help restore control of internal organs through precise electrical cues. I will discuss how we are closing the gap between invasive and non invasive techniques, bringing us closer to practical tools for rehabilitation, prosthetic control, and continuous health monitoring.

Session 4: Nanobiomaterials for sensing/imaging



Chair: Professor Dae-Hyeong Kim

Institute for Basic Science, Seoul National University, Korea



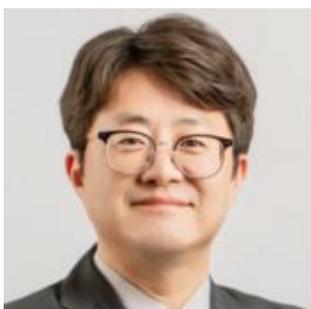
Dr Michael Booth

University College London, UK

Dr Booth is an Associate Professor of Chemical Biology and Organic Chemistry and University College London. He completed his PhD at the University of Cambridge and a Junior Research Fellowship at the University of Oxford. He started his independent group with a Royal Society University Research Fellowship.

Nucleic acid conjugates: remote control, targeting, and entirely new functions

We are entering the age of nucleic acid (DNA/RNA) technologies. DNA and RNA form the basis for many therapeutic and experimental technologies, including gene editing and silencing, nanotechnology, aptamers, and cell-free gene expression. However, their application is limited by the chemistry of nucleic acids. A major goal of the Booth group is the generation of nucleic acid conjugates to overcome current major challenges in their delivery and targeting, and to produce entirely new functions to increase their therapeutic potential. To this end, we have generated remote-controlled nucleic acids to reduce toxic on/off-target effects. We have also attached small molecule targeting agents to nucleic acids to take them to their site of activity or develop entirely new mechanisms of action. These nucleic acid conjugates will form the basis of a whole new suite of targeted therapeutics and technologies for basic research.



Professor Chulhong Kim

Pohang University of Science and Technology, Korea

Dr Chulhong Kim studied for his PhD degree under Professor Lihong Wang at Washington University in St. Louis. He currently holds Namgo Chair Professorship, Young Distinguished Professorship, and Mueunjae Chair Professorship of School of Convergence Science and Technology (Head), Convergence IT Engineering (Department Chair), Electrical Engineering, Mechanical Engineering, and Medical Science and Engineering (Program Chair) at Pohang University of Science and Technology in Republic of Korea. He has currently served as a Section Editor of Photoacoustics Journal (premier journal in the field), a Senior Area Editor of IEEE T. Medical Imaging, an Associate Editor of IEEE T. Biomedical Engineering, an Editorial Board Member of Biomedical Engineering Letters, etc. He is also elected as a member of the National Academy of Engineering of Korea (NAEK) and Young Korean Academy of Science and Technology (Y-KAST). He is a Fellow of the IEEE, SPIE, OPTICA, IAMBE and AIMBE.

Multimodal Photoacoustic Ultrasound Imaging: From Bench To Bedside and Products

Trans-energy imaging modalities have been significantly explored to overcome existing problems in conventional imaging modalities with respect to spatial/temporal resolutions, penetration depth, signal-to-noise ratio, contrast, and so on. Among them, photoacoustic imaging, an emerging hybrid modality that can provide strong endogenous and exogenous optical absorption contrasts with high ultrasonic spatial resolution, has overcome the fundamental depth limitation while keeping the spatial resolution. The image resolution, as well as the maximum imaging depth, is scalable with ultrasonic frequency within the reach of diffuse photons. In this presentation, the following topics will be discussed; (1) multiscale and multiparametric trans-energy imaging systems, (2) novel deep-learning powered image processing, (3) recent clinical study results in pathology, endocrinology, oncology, cardiology, dermatology, and radiology, (4) label-free ultrafast ultrasound Doppler imaging, and (5) efforts to commercialization.

Ultrastrong and Lightweight Materials

Co-chair opening session



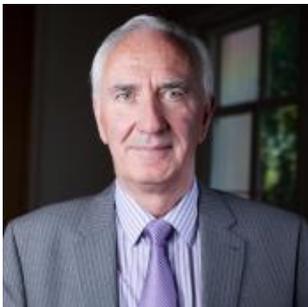
Chair: Dr Dimitrios Papageorgiou
Queen Mary University of London, UK



Professor Rodney S Ruoff
The Center for Multidimensional Carbon Materials, The Institute for Basic Science (IBS), Korea

Ultrahigh (specific) strength, stiffness, and toughness, of macroscale single crystal graphene

I provide an overview of our experimental measurements of tensile loading mechanics of macroscale single crystal graphene (SCG), and place measured values in context by referencing the highest strength human-made and commercially available material (Torayca-1200 carbon fiber). It is possible to forecast values for macroscale scale single crystal hexagonal boron nitride (SC-hBN), but they have not been experimentally measured/reported. Finally, I refer to hypothetical filaments or sheets of single crystal diamond, and of single crystal cubic boron nitride.



Professor Robert Young FEng FRS
University of Manchester, UK

The Mechanics of 2D Materials

The deformation and fracture behaviour of mechanically-exfoliated graphene has been studied in detail. Monolayer flakes of different lengths, widths and shapes were deposited onto PMMA beams and their fracture behaviour followed by deforming the beams. Through in-situ Raman mapping at different strain levels, the distributions of strain over the graphene flakes were determined from the shift of the graphene Raman 2D band. It was found that the strength of the monolayer graphene flakes decreased with increasing flake width from over 25 GPa to 5 GPa. The evolution and propagation of cracks in monolayer graphene and their associated stress fields was also studied using Raman spectroscopy and the fracture behavior of graphene interpreted using linear elastic fracture mechanics. It was shown that once crack propagation took place, the cracks became aligned approximately perpendicular to the tensile axis, regardless of crystallographic orientation.

The Raman mapping technique is applicable to a broad range of 2D materials. Monolayer hBN does not undergo resonant Raman scattering and so has a relatively weak spectrum, making strain measurement challenging. On the other hand, monolayers of 2D transition metal dichalcogenides (TMDs) such as WS₂ have well-defined Raman and fluorescence spectra enabling accurate strain mapping in single crystals.

Session 1: Novel architectures



Chair: Professor Robert Young FEng FRS
University of Manchester, UK



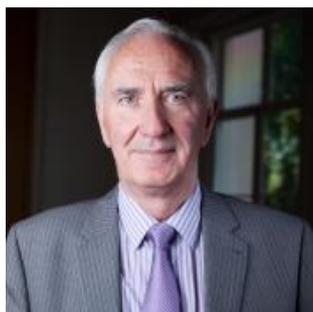
Professor Taek-Soo Kim
The Korean Advanced Institute of Science and Technology (KAIST),
Korea

Taek-Soo Kim is a tenured full professor in the department of mechanical engineering at Korea Advanced Institute of Science and Technology (KAIST), where he has been directing Advanced Packaging and Thin Film Lab (<http://aptf.kaist.ac.kr>) for 15 years. Professor Kim has pioneered novel tensile and adhesion testing of thin film and packaging materials that are crucial to advanced semiconductors, displays, and many other applications. He has authored 288 journal papers (citations 17108, h-index 61). He received a BS degree in 2001 from Yonsei University, and MS and PhD degrees in Mechanical Engineering in 2006 and 2010, respectively, both from Stanford University.

Mechanical Reliability of Thin Film Materials for Semiconductors, Displays and More

Advanced thin films are ubiquitous and important in many modern technologies. Most prominent applications include microelectronic devices, fuel cells, solar cells, OLED displays for which electrical, electrochemical, and optical properties of thin films are critical. However, while significant efforts have been directed to improving those properties, mechanical integrity of the thin films has been often ignored and even sacrificed. For example, new materials with unknown mechanical properties are increasingly being used, and in many cases they turn out to have inferior mechanical reliability. To make matters worse, thin film devices are being attempted to be mounted on flexible, foldable and even stretchable substrates, and this dramatically increases film deformation and stress resulting in cracking and delamination. All of these trends significantly sacrifice mechanical integrity of thin films and reduce device yield and reliability. This talk presents novel methods to measure and enhance mechanical properties of advanced thin films for semiconductors, displays and more. The topics to be discussed are 1) novel tensile testing of ultra-thin films on liquid surface platform, 2) adhesion and cohesion of advanced thin films, 3) warpage analysis by the digital image correlation (DIC) technique, and 4) stress reduction by controlling neutral planes.

Session 2: Synthesis of nanostructures



Chair: Professor Robert Young FREng FRS

University of Manchester, UK



Dr Won Kyung Seong

The Institute for Basic Science, Korea

Senior Research Fellow at the IBS Center for Multidimensional Carbon Materials, focusing on single-crystal growth, properties, and mechanical behavior of carbon allotropes such as graphene and graphite.

High-Strength Macroscale Carbon Films: Joule-Heating-Assisted Growth of Super-flat Graphene and Fabrication of Mirror-like Large-grained Graphite

We report the synthesis of high-strength carbon films, ranging from monolayer graphene to thick graphite, by controlling interfacial interactions with nickel-based catalysts. Growth within 3 minutes on Ni(111) foils using our home-built Joule heating system fabricates single-crystal graphene with sub-nanometer-level flatness over a $3 \times 5 \text{ cm}^2$ area. The single-crystal graphene maintains its flatness due to strong graphene–Ni(111) coupling, which suppresses surface deformation. This method yields graphene with an average Young's modulus of 962 GPa and a macroscale fracture strength of 39.1 GPa. This synthesis strategy was further applied to fabricate mirror-like, large-grained graphite films using Ni–Mo alloy melts. By vaporizing nickel to reduce the substrate–graphite interaction prior to cooling, fully AB-stacked films with millimeter-sized grains were obtained. These graphite films exhibit an average Young's modulus of 969 GPa and a fracture strength of 1.29 GPa, the highest reported value for macroscale artificial graphite. Notably, both materials demonstrate a Young's modulus approaching 1 TPa, comparable to that of ideal carbon materials. These films provide a scalable platform for electronic, thermal management, and mechanical applications.



Professor Milo Shaffer

Engineering and Physical Sciences Research Council, UK

Professor Milo Shaffer is Professor of Materials Chemistry at Imperial College and was co-Director of the London Centre for Nanotechnology (2010-2020). He is a leader in nanomaterials synthesis, modification, and hierarchical assembly, for applications in structural and multifunctional composites. He has pioneered the development of redox methods for nanocarbon processing, and at a larger scale, new hierarchical combinations of nanocarbons as structural electrochemical energy storage electrodes, coupling mechanical and electrochemical phenomena; structural composite energy storage topped the 2025 list of emerging technologies issued by the World Economic Forum. He currently leads the UK NextCOMP program on next generation composites in compression (www.nextcomp.ac.uk), focused on transforming compression strength of fibre reinforced polymer composites. He was awarded the RSC Meldola Medal (2005) and the RSC Corday-Morgan Prize (2014). He has published around ~340 peer reviewed journal papers and 35 patents, with 37000 citations, and an h-index (GS) of 94.

Incorporating nanostructures into next generation (sustainable) fibres

1D nanomaterials are particularly suited to improving performance and functionality of (structural) fibres. One strategy incorporates nanomaterial into existing state of the art fibres, to address critical weaknesses and/or introduce new functions. In this context, we have developed a continuous spool-to-spool process to graft CNTs onto (carbon) fibre by direct CVD across whole tows. The products show excellent single fibre and small composite performance in thermosets and thermoplastics. The second, more transformative route creates entirely new fibres from nanostructured constituents. High aspect ratio nanomaterials form nematics well suited to spinning, illustrated by examples using carbon nanotubide anions, imogolite nanotubes, cellulose nanocrystals, and synthetic proteins. The resulting fibres are relevant to sustainable structures, healable fibres, and structural supercapacitors. Sustainable systems include lignin based fibres spun in low cost ionic liquids, where small CNT loadings improve spinnability, carbon yield, and mechanical properties, offering a potential low cost, renewable carbon fibre route.

Session 3: Computational aspects



Chair: Professor Rodney S Ruoff

The Center for Multidimensional Carbon Materials, The Institute for Basic Science (IBS), Korea



Dr Ill Ryu

Seoul National University, Korea

Dr Ryu is currently an assistant Professor in the department of Materials Science and Engineering at Seoul National University. Prior to coming back to Korea, Dr Ryu worked at the department of Mechanical Engineering at University of Texas at Dallas for 7 years. Ill Ryu received his PhD degree in Materials Science and Engineering with minor in Mechanical Engineering from Stanford University. After completing his PhD, Dr Ryu continued his research as a postdoctoral research fellow and lecturer at Brown University. His research interests include multi-scale computational material science, materials mechanical size effect, mechanics of energy materials, and multi-physical modeling of materials science. Especially, his research focused on fundamental understanding of deformation mechanism, which is necessary to design robust and reliable devices from MEMS/NEMSs (Micro-/Nano-Electromechanical Systems) devices at small length scales to Airplane at large length scales.

Defect-driven plasticity and failure in heterogeneous nanomaterials

For optimal usage of heterogeneous nanomaterials in various industrial applications, it is critical to obtain fundamental understanding of deformation mechanisms at micron- and sub-micron length scale, where individual defects could play critical roles in exhibiting mechanical and functional properties. However, fundamental understanding of such mechanisms remains intriguing due to intricate interplay of both geometric characteristics and microscopic defects.

In this talk, we will discuss deformation mechanism at various length scale using a newly developed multiscale defect dynamics model, which could allow us to investigate collective motion of defects and their interaction as the basic building blocks for plastic deformation and the corresponding macroscopic mechanical response of heterogeneous nanomaterials. In addition, we employ a dislocation-based damage model using the developed multiscale defect dynamics model, which could provide a unique opportunity to investigate detailed dynamic evolution of microstructure during failure. The developed defect dynamics model will shed light on fundamental investigation of “defect-controlled” mechanical behaviors in heterogeneous nanomaterials under various multi-physical environments.



Professor Nicola Pugno

Queen Mary University of London, UK

Nicola Maria Pugno is an Italian mechanic, mechanical engineer, physicist, holding PhDs in fracture mechanics and biology. Professor of solid and structural mechanics at the University of Trento, part-time professor of materials science at Queen Mary University of London and visiting professor at the University of Oxford. He has been appointed to several committees, including the technical and scientific committee of the Italian Space Agency, and has served as a plenary speaker at numerous international workshops, events and conferences, such as Falling Walls, at the World Economic Forum and the European Parliament invited by the European Research Council (ERC) as well as -as opening plenary speaker- at the International Conference of Theoretical and Applied Mechanics (2020+1). For his scientific contributions in different mechano-X topics he has received several awards, including the A. A. Griffith Medal and Prize in 2017 and the Humboldt Research Award in 2022. Since 2011, he has secured several grants from the European Union mainly under the Excellent Science pillars (including ERC grants) for both fundamental science and high-tech transfer, which he develops for various high-tech industries.

1D, 2D and 3D Superstrong Lightweight Materials, Composites and Size Effects

In this talk, I present the nanomechanics of hierarchical carbon materials spanning dimensional transitions from 1D carbon nanotubes to 2D graphene and 3D aerographite, including related reinforced composites. The central objective is to understand how exceptional nanoscale strength and toughness scale up to macroscopic structural performance, and how defects govern failure across scales.

As an extreme benchmark application, we examine the mechanical feasibility of carbon-based tether materials for a space elevator, considering carbon nanotube and graphene bundles as candidate load-bearing elements. The concept is also framed in the context of asteroid mining.

Meeting day 2
Thursday 5 March 2026

Plenary session



Professor Taeghwan Hyeon FRSC

The Institute for Basic Science, Korea

Taeghwan Hyeon received BS (1987) & MS (1989) degrees from Seoul National University (SNU), and PhD degree (1996) from UIUC, all in Chemistry Department. He is a SNU Distinguished Professor, and Director of Center for Nanoparticle Research of Institute for Basic Science (IBS). He is recognized for his outstanding contributions in scalable synthesis of uniform-sized nanoparticles and related nanomaterials for energy & catalysis & medical applications. He was listed in Highly Cited Researcher (2014~25), and chosen as 2020 Citation Laureate in Chemistry. He received 2022 Grand Prize of National Academy of Engineering of Korea (NAEK), 2016 Presidential Best Scientist Award, 2012 Samsung Hoam Prize, and 2008 POSCO-T.J. Park Award. He is an elected Member of KAST&NAEK in Korea, US National Academy of Engineering, Royal Swedish Academy of Engineering Sciences, and Royal Society of Chemistry. From 2010 to 2020, he served as Associate Editor of JACS, and now of ACS Nano.

What and how can nano do for medicine?

Over the last 20 years, our laboratory has focused on the designed chemical synthesis, assembly and medical applications of uniform-sized nanocrystals and related nanomaterials.1 We reported that uniform 2 nm iron oxide nanoclusters can be successfully used as T1 MRI contrast agent for high-resolution MR angiography of monkeys.2 We report a highly sensitive and selective K⁺ nanosensor that can quantitatively monitor extracellular K⁺ concentration changes in the brains of freely moving mice experiencing epileptic seizures.3 We demonstrated that ceria-based nanoparticles can work as therapeutic antioxidants to treat various intractable diseases, including ischemic stroke, sepsis, rheumatoid arthritis, inflammatory bowel disease, and cardiovascular disease, and as radioprotectants.4 We demonstrated that ceria nanoparticle and mesenchymal stem cells work not only individually but also cooperatively toward a comprehensive rheumatoid arthritis treatment.5 We engineered a Sucralfate-based oral coacervate formulation that stably incorporates antioxidant cerium oxide nanoparticles to uniformly coat the gastrointestinal tract within hours and treat oxidative stress driven intestinal injuries, including DSS colitis and radiation-induced enteropathy.6 We fabricated ultraflexible and/or stretchable soft-electronic and optoelectronic devices integrated with various functional nanomaterials and their applications to wearable and implantable medical and healthcare devices.7 We fabricated electrically conductive and elastic Ag&Au-based nanowire-rubber nanocomposites to treat cardiovascular diseases such as heart failure and ventricular tachyarrhythmia.8 We fabricated highly conductive and elastic nano-electrodes for their applications to healthcare and skin electronic devices.9

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Nanoscience for Medicine

Session 5: AI driven nanobiomaterials



Chair: Dr Maya Miller

University of Oxford, Kavli Institute for Nanoscience, UK



Dr Íris Luz Batalha

Department of Life Sciences, University of Bath, UK

Íris joined the University of Bath as an Associate Professor (Senior Lecturer) in 2025, leading the Nanolmmunology and Molecular Pharmaceutics group. She is also a Course Director in Nanomedicine at the University of Cambridge and serves as a Senior Innovation Strategy Consultant. Her previous experience includes roles as a “La Caixa” Junior Leader at IBEC Barcelona, a joint Postdoctoral Researcher at the University of Cambridge and MedImmune/AstraZeneca, and consultant roles in Competitive Intelligence and Innovation Strategy at CHR and Inspiralia. In 2019, she co-founded the non-profit Women Ahead of Their Time (WATT) CIC. Her research expertise lies in medical and pharmaceutical R&D, with a focus on nanomedicine, bio-inspired materials, downstream processing, formulation, and drug delivery.

Leveraging Infection-Induced Metabolite Signalling for the Targeted Delivery of Nanotherapeutics

The global rise of multidrug-resistant intracellular pathogens represents a critical public health challenge, as these organisms effectively evade both host immunity and conventional systemic antibiotics. While antibiotic-drug conjugate nanoparticles (nanobiotics) have demonstrated improved therapeutic efficacy and reduced toxicity *in vivo* compared to free drugs, achieving sitespecific delivery to infected host cells remains a significant challenge. We are developing a proof-of-concept for a dynamic targeted therapy that exploits the metabolic signature of infection. Our approach leverages the MHC class I-like related (MR1) protein, an evolutionarily conserved antigen-presenting molecule. In healthy cells, MR1 is primarily sequestered within the endoplasmic reticulum; however, upon binding specific bacterial-derived metabolites produced during active infection, MR1 undergoes a conformational shift and translocates to the cell surface. By engineering delivery vehicles that selectively recognise the MR1-antigen complex, we aim to enable a dynamic “search-and-bind” mechanism that is only activated in the presence of pathogens. This approach shifts the targeting logic from static cell surface markers to a responsive system governed by real-time microbial metabolism, offering a new axis for targeted therapeutic intervention.



Professor Sunghoon Kwon

Seoul National University, Korea

Sunghoon Kwon is a Professor in the Department of Electrical Engineering at Seoul National University and currently serves as President of the SNU Bio-MAX Institute. He received his PhD in Bioengineering from the University of California, Berkeley (UCB/UCSF Joint Program) and completed postdoctoral training at Lawrence Berkeley National Laboratory. His research spans micro/nanofluidics, spatial omics, and diagnostic technologies, with publications in *Nature*, *Nature Biotechnology*, *Nature Materials*, and *Science Translational Medicine*. Professor Kwon is the founder and CEO of QuantaMatrix and a founder and scientific advisor of Celeemics, translating academic innovations into commercial products. His work has led to clinically and industrially deployed technologies in antimicrobial susceptibility testing and bioassays. He has received numerous honors, including the Incheon Award and the Presidential Young Scientist Award, recognising his contributions to biomedical engineering and translational research.

The AI-Nano Nexus: Smart Lasergun and uRAST for Personalized Medicine

The convergence of artificial intelligence and nanotechnology is revolutionising personalised medicine. This presentation explores "The AI-Nano Nexus," highlighting two pioneering research projects in my laboratory that serve as prime examples of successfully translating cutting-edge academic research into impactful commercial products.

The first half introduces the "Smart Lasergun," focusing on Spatially-Resolved Laser Activated Cell Sorting (SLACS) paired with Tumor-Environment-Associated (TEA)-graph deep learning. Synergising spatial multi-omics with graph neural networks, this platform utilises targeted laser retrieval to mine novel molecular and image biomarkers directly from pathological images. Unlocking the complexities of the tumor microenvironment with AI and laser technology establishes a robust framework for automated biomarker discovery.

The second half shifts to ultra-Rapid Antimicrobial Susceptibility Testing (uRAST), a groundbreaking sepsis diagnostic technology with the profound potential to save countless lives. By employing synthetic peptide-coated nanoparticles to selectively recover pathogens directly from whole blood, uRAST bypasses lengthy culture protocols. Clinically validated across 190 patients, it delivers accurate drug susceptibility profiles in just 13 hours—reducing conventional turnaround times by up to 60 hours.

Together, these commercialised innovations illustrate how integrating AI with advanced nanotechnology turns complex spatial and microbiological data into rapid, individualised clinical actions, offering great tools for personalised medicine.

Session 6: AI and digital medicine



Chair: Professor Dae-Hyeong Kim

Institute for Basic Science, Seoul National University, Korea



Professor Namshik Han

Department of Quantum Information, Yonsei University, Korea

Professor Namshik Han is a computational biologist and AI scientist whose work bridges academia and industry at the frontier of drug discovery. He leads the AI Research Group at the Milner Therapeutics Institute, University of Cambridge, where he also serves as Faculty at the Cambridge Centre for AI in Medicine and as an Affiliated Principal Investigator at the Cambridge Stem Cell Institute.

At Yonsei University, he is Professor in the Department of Quantum Information and an IBS Professor at the Institute for Basic Science (Center for Nanomedicine). His research combines quantum computing and artificial intelligence to uncover disease mechanisms from multi-modal biomedical data, advancing next-generation therapeutic discovery.

Beyond academia, Namshik has been a driving force in translating computational science into real-world impact. He co-founded CardiaTec Biosciences, which integrates AI with human heart tissue multi-omics for cardiovascular drug discovery, and KURE.ai Therapeutics, focused on NK cell-based immuno-oncology. Earlier in his career, he was part of the founding scientific team of Storm Therapeutics, one of Cambridge's leading RNA-modification biotech companies.

Revealing the Unseen: Convergence of AI-driven Target Discovery and Nanomedicine

The role of AI and data-driven methodologies is set to play a pivotal part in the drug discovery industry, unravelling the intricate details of disease mechanisms and streamlining the development of therapeutics. In this seminar, I will provide an overview of how AI and Multi-Omics integration are enhancing the identification and profiling of therapeutic targets.

Specifically, I will present a translational case study demonstrating how computational insights can be realized through nanomedicine. Our recent research on Chronic Myeloid Leukaemia (CML) utilized network-based simulations to identify key apoptotic regulators, BIM and MCL-1, as critical therapeutic targets. To validate this computational prediction, we developed Viral/Non-viral Chimeric Nanoparticles (ChNPs) capable of simultaneously expressing BIM and silencing MCL-1. This multimodal gene therapy, delivered via ChNPs, demonstrated significant synergistic effects with the targeted drug Dasatinib in suppressing leukemic proliferation. This study exemplifies the power of combining AI-driven target discovery with advanced nanoparticle delivery systems.

Finally, I will introduce our future research direction at the Yonsei IBS Center for Nanomedicine. We aim to integrate 'Physical AI' with Nanorobotics, moving

beyond digital computations to create intelligent nano-agents capable of physical interaction within the biological environment. This convergence of AI and nanotechnology promises to enable ultra-precise control and autonomous functionality in next-generation medical nanorobots.



Professor Gavin Jell
University College London, UK

Gavin Jell is a Professor of Nanotechnology and Regenerative Medicine at UCL. His research focuses on understanding how materials (including nanomaterials) interact within biological environments to develop improved functionality and more predictable in vitro models. He is the Director of UCL's MSc in Nanotechnology & Regenerative Medicine and a Trustee of the British Society of Nanomedicine (BSNM), where he's leading a national higher education nanomedicine course accreditation programme to enhance training in nanomedicine. He will also host the BSNM Annual Conference 2026 at UCL. Through these roles, Gavin aims to strengthen collaboration across the interdisciplinary nanomedicine community, harmonise education standards and improve the translation of emerging nanotechnologies in healthcare.

When Biology Takes Over: How Uncontrolled Interactions Redirect Nanoparticle Fate

Despite over 20,000 papers and three decades of research, no receptor targeted nanoparticle has yet reached the market. This may, in part, be due to non specific interactions between nanoparticles and molecules present in the biological environment, and the formation of the protein corona. Across the nanoparticle targeting literature, >94% of in vitro models rely on foetal bovine serum (FBS), and <3% match serum species to cell species - conditions that limit predictive validity and obscure mechanisms of nanoparticle uptake. This talk highlights the importance of serum species in determining AuNP uptake, and the role of immunoglobulins and lipoproteins in shaping both the physicochemical properties of nanoparticles and their interactions with cells. The talk will also discuss the need for minimal publishing standards and more physiologically relevant in vitro models, both essential for improving reproducibility and accelerating the translation of nanomedicines.

Session 7: Soft Nano Materials



Chair: Professor Dame Carol Robinson DBE FMedSci FRSC FRS

University of Oxford, UK



Dr Maya Miller

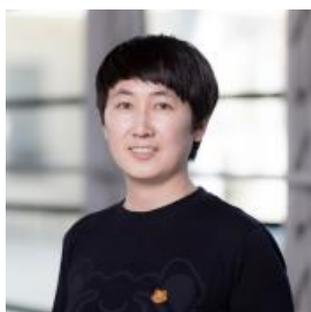
University of Oxford, Kavli Institute for Nanoscience, UK

The Nanoscience of Collagen Integrity: Programming Regeneration Through Molecular Crosslink Design

Procollagen lysyl hydroxylase 1 (PLOD1) is emerging as a molecular regulator of collagen structural integrity. We have discovered that intact PLOD1 exists in distinct oligomeric proteoforms with context-dependent glycosylation and activity, revealing a previously unrecognized layer of extracellular matrix (ECM) quality control that is invisible to gene-level analyses.

In skin, PLOD1-driven collagen crosslink chemistry dictates matrix stiffness, resilience, and stress relaxation — parameters that directly instruct fibroblast behavior in aging and fibrosis. By resolving how specific proteoform states map onto crosslink architecture, we translate protein-level regulation into quantitative material design rules. These insights guide the engineering of collagen–elastin composites and tunable hydrogels that recapitulate the compliant mechanics of youthful dermis.

This work reframes ECM biology as a blueprint for materials chemistry, positioning proteoform-defined crosslink signatures as instructive cues for regenerative scaffold design.



Dr Liyun Ma

Imperial College London, UK

Dr. Liyun Ma is an Assistant Professor in Advanced and Intelligent Textiles at Imperial College London and a Visiting Researcher in Professor Dame Molly Stevens' group at the University of Oxford. Her research focuses on intelligent devices and advanced textiles for human-centered applications, integrating multidisciplinary and AI-assisted engineering approaches. Her work spans wearable monitoring systems, closed-loop biomedical devices, smart textiles, AI-powered sensing for human–robot interaction, energy harvesting, and scalable textile manufacturing. She received her PhD in Textile Engineering from Donghua University in 2021 and completed postdoctoral training at Oxford and Imperial. Dr. Ma has published over 50 peer-reviewed papers, holds 23 patents, and was Highly Commended in the 2024 L'Oréal-UNESCO For Women in Science UK & Ireland Rising Talents Award.

From Functional Fibres to Intelligent Textile Systems for Human-Centred Applications

Talk abstract not provided

Session 8: Neural and cardiac interfaces



Chair: Professor Jinwoo Cheon

The Institute for Basic Science (IBS) Center for Nanomedicine, Korea



Professor Dae-Hyeong Kim

Institute for Basic Science, Seoul National University, Korea

Sustainable Power Supply Solution for Soft Implantable Bioelectronics

Recent advances in soft bioelectronics have attracted considerable attention due to their potential applications in personalised, bio-integrated healthcare systems. A primary challenge in this field arises from the mechanical mismatch between conventional rigid electronic devices and the soft, dynamic nature of human organs. To address this challenge, novel materials for soft, stretchable electronic devices have been developed, offering mechanical and chemical properties more compatible with in vivo cellular environments.

Despite these advances, current stretchable conductive materials typically exhibit lower conductivity than commercial implantable devices, which leads to higher power consumption and more frequent battery replacement. This talk introduces a sustainable power supply solution for soft implantable bioelectronics to overcome these limitations. An all-solid-state thin-film lithium-ion battery, combined with parity-time symmetric long-range wireless power transfer, represents a promising approach. This system eliminates the need for periodic battery replacement, thereby significantly reducing the physical and economic burdens on patients. Key technological challenges and future research directions will also be briefly discussed. Ongoing efforts in developing unconventional materials and bioelectronic systems are expected to have a profound impact on addressing unmet needs in clinical medicine.



Professor Andrew Jackson

Newcastle University, UK

Andrew Jackson is Professor of Neural Interfaces and Co-Director of the Centre for Transformative Neuroscience at Newcastle University. His work explores the scientific and clinical applications of bidirectional, closed-loop interfaces between the nervous system and technology. He is the co-founder of two neurotechnology start-ups, MintNeuro Ltd and Neudio Ltd.

Opportunities at the interface of neuroscience and nanoscience

Neurological conditions are now the leading cause of death and disability worldwide, surpassing cardiovascular disease as the top cause of disability-adjusted life years. As the pipelines of new pharmaceuticals dry up, we are increasingly looking to new technologies to tackle disease burden. Neural interfaces that sense and stimulate the brain, spinal cord and nerves offer new therapeutic opportunities to monitor and manipulate the state of the nervous system. However, our current neurotechnologies are blunt tools with which to interact with the complex molecular machinery of neurons and the distributed networks of neural circuitry that underlie brain function. This talk will describe the challenges faced in translating neuroscientific discoveries into scalable therapies and the possibilities that may be unlocked by engineering the brain and technology at the nanoscale.

Ultrastrong and Lightweight Materials

Session 4: Layered Structures



Chair: Professor Seung Min Jane Han

The Korea Advanced Institute of Science and Technology, Korea



Dr Florian Bouville

Imperial College London, UK

Florian Bouville is an Associate Professor in the Centre for Advanced Structural Ceramics in the Department of Materials of the Imperial College London. His group is researching both colloidal processing and fracture mechanics, to design more robust and durable materials based on their microstructure and not composition, with applications ranging from high temperature structural components for aerospace to energy storage devices. These studies are supported by various funding sources, including an ERC Starting Grant and the European Space Agency.

He obtained his Master's degree in Material Sciences at the Institut National des Sciences Appliquées de Lyon (INSA de Lyon, France) in 2010. He then moved to the South of France for his PhD between three partners: the company Saint-Gobain, the LSFC and the MATEIS laboratory (INSA de Lyon). From 2014 to 2018, he was a postdoctoral researcher and then scientist in the Complex Materials group at ETH Zürich.

Exploring the link between microstructure, order, and toughness in bioinspired lightweight composites

Natural composites leverage intricately ordered microstructures to meet demanding functions. Nacre, a brick and mortar archetype, exhibits fracture toughness about 40 times that of its mineral constituent because propagating cracks activate multiple toughening mechanisms and create millimetre scale process zones. This paradigm has guided the design of synthetic ceramics for years now. Our nacre inspired alumina composites reach strengths up to 670 MPa and K_{IC} up to 7 MPa.m^{1/2} with stable crack growth maintained to 1200°C. However, these systems still do not reproduce nacre's large process zones. To probe the role of order on process zone formation, we engineered a composite from monodisperse silica rods that self assemble into colloidal crystals. The resulting material, processed entirely at room temperature and containing 80 vol% ceramic, delivers a 40-fold toughness increase relative to the polymer matrix. By decoupling architecture from composition, we clarify how ordering amplifies extrinsic toughening without sacrificing stiffness. More broadly, these results outline the requirements to produce damage tolerant composites with application relevant combinations of strength, toughness, and density.



Professor Seunghwa Ryu

The Korean Advanced Institute of Science and Technology, Korea

Dr Seunghwa Ryu is an Endowed Chair Professor in the Department of Mechanical Engineering at KAIST (Korea Advanced Institute of Science and Technology) and Director of the KAIST InnoCORE PRISM-AI Center, a national research center for AI-based intelligent design and manufacturing integration. He received his PhD in Physics from Stanford University in 2011 and his BS in Physics from KAIST in 2004. He has served as a visiting professor at the University of California, Berkeley (2024) and Stanford University (2018). His research focuses on knowledge-guided artificial intelligence for materials and manufacturing, integrating multiscale physical modeling, data-efficient AI-based design optimization, and human-AI collaborative systems. He has published over 170 international journal papers in leading journals including Nature Communications, Advanced Materials, npj Computational Materials, and Computer Methods in Applied Mechanics and Engineering. His honors include the APACM Award for Young Investigators in Computational Mechanics (2019) and election to the Young Korean Academy of Science and Technology (Y-KAST, 2022).

Knowledge-Guided AI for Data-Efficient Design of Architected Materials

Architected materials offer unprecedented opportunities to achieve extreme combinations of mechanical properties through geometry rather than composition. However, their design space is inherently vast, high-dimensional, and severely constrained by limited experimental and computational data. This talk presents a knowledge-guided, data-efficient AI framework for the inverse design of architected materials, integrating Bayesian optimization and physics-informed neural networks (PINNs). First, I introduce multi-objective Bayesian optimization guided by mathematical domain knowledge to efficiently explore plausible design spaces for strut- and shell-based architectures. By embedding structural symmetries, geometric parameterizations, and uncertainty-aware Gaussian process surrogates, we achieve record-high specific stiffness and strength with datasets orders of magnitude smaller than those required by purely data-driven approaches. These designs are experimentally validated across micro- to macro-scales using advanced additive manufacturing. Second, I present a physics-informed PINN framework for data-free design of transformative origami metamaterials. By directly learning and shaping energy landscapes under physical constraints, the framework enables inverse design of multistable and sequentially deployable structures. Together, these examples demonstrate how knowledge-guided AI can overcome data scarcity, improve out-of-distribution reliability, and establish a new paradigm for the next frontier of architected materials design.

Session 5: Interfaces



Chair: Dr Dimitrios Papageorgiou
Queen Mary University of London, UK



Professor Gi-Dong Sim
The Korean Advanced Institute of Science and Technology, Korea

Gi-Dong Sim is an associate professor at Korea Advanced Institute of Science and Technology (KAIST) where he leads the in-situ characterization and reliability evaluation (iCaRE) laboratory in the department of mechanical engineering. Prior to joining KAIST in 2018, he conducted research at Johns Hopkins University, Harvard University, and at KAIST. His group research is focused on developing experimental techniques to test the mechanical behavior of metallic materials at various length-scales and in different environments, on the development of advanced metallic alloys and devices that can reliably operate in extreme environments, and on elucidating deformation mechanisms of materials in extreme environments.

Aluminum-Carbon Thin Films with High Strength and Ductility

We report the exceptional mechanical properties of aluminum–carbon (Al–C) thin films deposited by multi-source co-sputtering. A high-throughput combinatorial approach was employed to investigate the mechanical and electrical properties of compositionally graded Al–C films. Hardness increased with carbon addition, albeit at the expense of electrical conductivity. Rapid screening revealed that regions containing 6.4 at% C achieved a favorable balance between hardness (2.8 GPa) and conductivity (142 Ω -nm). Micro-tensile experiments on freestanding Al, Al–C 6.4 at%, and Al–C 10.3 at% films were conducted to evaluate tensile properties and elucidate the strengthening mechanism. Both Al–C 6.4 at% and 10.3 at% films exhibited markedly higher yield stresses exceeding 300 MPa while retaining ductility. In both cases, plastic flow initiated at an upper yield point, followed by a stress drop to a lower flow stress. The magnitude of the stress drop was \sim 5% for Al–C 6.4 at% and $>$ 10% for Al–C 10.3 at%. This distinct yield-drop behavior resembles that of low-carbon steel, where it is attributed to the formation of a “Cottrell atmosphere.” Uniaxial tensile tests with repeated unloading–aging–reloading cycles confirmed that the yield drop intensified with longer aging times and higher temperatures. Comprehensive microstructural analysis demonstrated that the formation of a Cottrell atmosphere is the primary deformation mechanism in Al–C thin films.



Professor Manish K Tiwari
University College London, UK

Professor Tiwari is a Royal Society Wolfson Fellow and Professor of Nanoengineering in UCL Mechanical Engineering. He directs the Nanoengineered Systems Laboratory at UCL and serves on the Management Board of UCL Institute of Healthcare Engineering.

His healthcare research is hosted by the UCL Hawkes Institute, and he is a member of the steering team of UCL’s Manufacturing Futures Laboratory, a

new centre dedicated to advanced materials and manufacturing technologies. His research has received four prestigious grants from the European Research Council (ERC). He advises two start-up companies, is on the Board of the Royal National Orthopaedic Hospital NHS Trust, Stanmore and is a member of the editorial teams of three international journals.

Robust nanoengineered interfaces without toxic ingredients

There are numerous well-known and extensively studied examples of slippery surfaces in plants, such as lotus leaves, rose petals and pitcher plants, and in animals, including polar bear fur, shark skin and butterfly wings. However, these elegant natural systems have not evolved to meet the severe robustness requirements that practical engineered surfaces are often required to withstand.

In this presentation, I will focus on two strategies to address some of these limitations. First, I will demonstrate how mechanical flexibility can be exploited to enhance robustness. Second, I will show how pitcher-plant-inspired surfaces can be designed to withstand high-speed liquid impacts. These strategies could be instrumental in eliminating the use of poly- and perfluoroalkyl substances (PFAS) in slippery surface treatments, which pose major environmental and human health concerns. Emerging engineered surface examples based on reticular porous materials and architected microstructures will be presented to demonstrate resilience to liquid impacts at speeds approaching those encountered in category five hurricanes.

Session 6: Multifunctional nanocomposites



Chair: Professor Rodney S Ruoff

The Center for Multidimensional Carbon Materials, The Institute for Basic Science (IBS), Korea



Dr Dimitrios Papageorgiou

Queen Mary University of London, UK

MXene-Engineered Interfaces for Ultrastrong, Lightweight and Multifunctional CFRPs

In this talk I will present our recent work on advancing lightweight carbon fibre reinforced polymer composites by engineering the fibre–matrix interface with MXene nanoplatelets, turning conventional CFRPs into multifunctional structural materials. Using an optimised electrophoretic deposition route, we deposited 2D $\text{Ti}_3\text{C}_2\text{T}_x$ MXene uniformly onto carbon fibre surfaces to create scalable MXene–CF hybrids. This controlled interfacial architecture increases fibre surface energy and wettability, tailors surface roughness, and strengthens load transfer, delivering a clear improvement in interfacial strength and flexural performance beyond the state-of-the-art.

Building on this platform, we combined MXene modified fibres with post-deposition thermal annealing to develop conductive interphases that preserve mechanical integrity while enabling electrical functionality and in situ damage sensing. Finally, we introduced a tri-core-shell design assembled by sequential, layer-by-layer processing that integrates MXene, nickel particles, and carbon fibres to achieve high electrical conductivity, strong EMI shielding, and efficient Joule heating. These capabilities directly address practical challenges such as lightning strike mitigation and anti-icing or de-icing under harsh weather conditions, with a clear route towards cost effective manufacturing.

Finally, I will highlight the opportunities emerging from these results in high performing multifunctional nanocomposites, showing how the integration of 2D materials with scalable manufacturing and reinforcement strategies can expand the design space for ultra strong and lightweight materials, and enable structural composites with enhanced electromechanical performance.



Professor Seung Min Jane Han

The Korea Advanced Institute of Science and Technology, Korea

Strengthening and Toughening Mechanisms in Metal-Graphene Nanolayered Composites

Nanoscale metal-graphene nanolayered composites are known to have ultra-high strength due to the ability of graphene to effectively block dislocations from penetrating through the metal-graphene interface. The same graphene interface can deflect generated cracks, thereby serving as a toughening mechanism. In this talk, the role of graphene interfaces in strengthening and toughening the Cu-graphene nanolayered composite will be discussed. In-situ TEM tensile testing of Cu-graphene showed that the dislocation plasticity was strongly confined by the graphene interfaces and the grain boundaries. The weak interfacial bonding between Cu-graphene induced an interesting stress

decoupling effect, which resulted in independent deformation of each Cu layer. MD simulations confirmed such independent deformation of each Cu layer and also showed that the graphene interfaces effectively block crack propagation as delamination occurs at the Cu-graphene interfaces to allow for elastic strain energy dissipation. Bending fatigue testing was also conducted on Cu-graphene nanolayered composites that indicated ~5 times enhancement in robustness against fatigue-induced damage in comparison to the conventional Cu only thin film. Such an enhancement in reliability under cyclic bending was found to be due to the ability of the graphene interface to stop fatigue-induced crack propagations through thickness of the thin film, which is contrary to how a metal only thin film fails under cyclic loadings.

Session 7: Graphene related aspects



Chair: Professor Seung Min Jane Han

The Korea Advanced Institute of Science and Technology, Korea



Professor Ian Kinloch

University of Manchester, UK

Professor Ian Kinloch is a Professor of Materials Science at the University of Manchester and the Chief Scientific Officer of the Henry Royce Institute, the UK's national materials institute. He has previously held the Royal Academy of Engineering/Morgan Advanced Materials Research Chair and an EPSRC Challenging Engineering Fellowship. Ian's research focuses on taking nanomaterials from production through to processing and application in composites and energy technologies. His work bridges the divide between academia and industry, involving collaborations with a range of companies.

Enabling functionality in lightweight materials through the introduction of nanofillers

Carbon nanomaterials possess a unique combination of properties that make them highly effective reinforcements in composite systems, particularly when integrated into hybrid architectures alongside other fillers.

Our work will begin with an investigation of percolated network formation using a combination of experimental characterisation and Monte Carlo simulations. These fundamental insights will then be extended to hybrid systems to study the interactions among carbon nanotubes, graphene, and carbon black during network development. Building on this understanding, we will explore several application areas for conductive composites, including graded insulators for high-voltage power transmission, out-of-autoclave repair of carbon-fibre composites, non-destructive terahertz imaging, and structural health monitoring.

We will also examine how the exceptional barrier performance of graphene can enhance ultra-high-molecular-weight polyethylene (UHMWPE) as a sealing material, with the long-term goal of providing an alternative to PFAS-derived fluoropolymers. Finally, we will assess the resilience of these materials and structures to multiple recycling cycles to evaluate their suitability for circular-economy manufacturing.



Dr Anirban Kundu

The Center for Multidimensional Carbon Materials, the Institute for Basic Science (IBS), Korea

Anirban Kundu is a Senior Researcher at the Center for Multidimensional Carbon Materials, Institute for Basic Science (IBS), Republic of Korea, where he works on the synthesis, mechanics, and device integration of two-dimensional materials. He received his PhD in Physical Science from the Indian Institute of Science Education and Research (IISER) Mohali, India, with a focus on the structural and opto-electronic properties of black phosphorus studied through advanced Raman spectroscopy. With over a decade of

experimental experience, his expertise spans large-area single-crystal graphene growth, cleanroom microfabrication, macroscale mechanical testing, and advanced spectroscopic and scanning probe techniques. His research bridges fundamental physical understanding with reliable experimental methodologies, reflecting a strong respect for classical solid-state physics while advancing next-generation 2D material platforms for electronic, optoelectronic, and sensing applications.

Macroscale Mechanical Properties of Single-Crystal Graphene *presented by Rodney S Ruoff*

'High end' values of Young's modulus (E) and particularly, of tensile strength (σ), have been reported for monolayer graphene: but for strength (particularly) there are only reports for samples in the micrometer length scale.[1] We are studying the macroscale mechanics of single crystalline adlayer-free monolayer graphene (SCG) by polymer thin film-assisted tensile testing to 'extract' the values of E and s for SCG.[2] We have measured the mechanical properties of centimeter-scale SCG using 'dog bone' samples with edges aligned along specific crystallographic directions. We thereby learned that the strongest samples have the zig zag (zz) direction oriented along the long axis of the gauge in the dog bone samples. The limiting strength (σ) of 'zz-SCG' (the stress at which the first crack occurs) was extracted from the linear region of zzSCG-PC stress strain curves (just prior to each curve becoming non-linear). The SCG was synthesized using chemical vapor deposition (CVD) on single-crystal Ni(111) foils and the dog bone samples were tensile loaded with a custom-built 'float-on-water' (FOW) tensile system that allows for in situ observation of crack initiation and propagation. These findings highlight the remarkable mechanical performance of macroscale SCG, establishing it as a promising material for a wide range of applications, including aerospace, flexible electronics, and straintronics. This work is supported by the Institute for Basic Science (IBS-R019-D1).

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