Functional Diamond Symposium 2022

Zhengzhou Research Institute for Abrasives & Grinding Co., Ltd.

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Symposium Announcement

To whom it may concern,

On behalf of the organizing committee, I would like to invite you to attend the Functional Diamond Symposium 2022 scheduled on **November 9th, 2022**. The objective of the symposium is to promote science exchange and collaboration. The symposium will be held virtually via **Zoom** and the registration is free of charge. Please feel free to circulate this information to those who may be interested.

Agenda

Beijing Time (UTC/GMT +8)	Speaker	Title of Talk
14:00-14:30	Nianjun Yang	Diamond Supercabattery: Design and Performance
14:30-15:00	Hiroshi Kawarada	Power & RF Diamond FETs Based on Surface Terminations
15:00-15:30	Jianbo Liang	AlGaN/GaN/3C-SiC-on-diamond high electron mobility transistors (HEMTs) fabrication by diamond room temperature bonding
15:30-16:00	Break	
16:00-16:30	Dong Liu	Real time imaging of the damage and fracture of nuclear-grade graphite at elevated temperatures
16:30-17:00	Roger Webb	Ion Implantation of Diamond
17:00-17:30	Michael Chen	Diamond nanoneedle arrays for high-throughput intracellular delivery

Attached are the introductions to the speakers and talks.

Please register via the following link before November 8th, 2022:
https://us06web.zoom.us/webinar/register/WN_zrvHUHCQTmyA_yido7dnRg
You will receive the Zoom meeting link after registration. The symposium is supported with simultaneous interpretation in English and Chinese. You can choose either language via Zoom.

Your presence at the symposium will be much appreciated.

Yours faithfully,

Editorial office of *Functional Diamond*

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Introductions to the speakers and talks Back to the Agenda

Time 15:00-15:30 (UTC/GMT +9, Tokyo) 14:00-14:30 (UTC/GMT +8.00, Beijing) 6:00-6:30 (UTC/GMT 0, London)

Speaker	Nianjun Yang	
Affiliation	Institute of Materials Engineering, University of Siegen, Germany	
Title of the talk	Diamond Supercabattery: Design and Performance	

Abstract of the talk

Energy crisis is one of the biggest challenges for our society. Efficient storage and conversion of the energy captured from existing sources are thus of great significance. Electrochemical energy storage is such an approach where advanced electrode materials need to be developed and synthesized. In this talk, our strategies to design and synthesize different diamond materials and their composites will be detailed. The application concepts of diamond materials and their composites as the capacitor electrodes for the ensemble of high-performance supercapacitors as well as the performance of these diamond supercabatteries will be highlighted.

Introduction to the speaker

Dr. Nianjun Yang works as a senior scientist and the group leader of nanomaterials at the Institute of Materials Engineering, University of Siegen, Germany, where he finished his habilitation in December 2020 and was promoted to Privatdozent in January 2021. His current research interests cover synthesis of functional materials (mainly advanced carbon materials) as well as their electrochemical applications in the fields of chemical/biochemical sensing, energy storage and conversion, and sustainable chemistry. He has published over 200 papers in peer-reviewed journals, editing/ed 1 book series (nanocarbon chemistry and interfaces, Wiley) with 6 volumes, 4 books, contributed 11 book chapters, delivered 38 invited talks and 57 oral presentations at international conferences. He is associated editor of Materials Lab, member of the Editorial Advisory Board of Nano Research Energy since 2022, Materials Future since 2011, Diamond and Related Materials since 2017 and Scientific Reports since 2016, the program member of Hasselt Diamond Workshop since 2013 and International conference of diamond and related materials since 2014 as well as Nanodiamond and new carbon (NDNC) in 2016, a guest-editor of 12 journals (e.g., Accounts of Chemical Research, Small, Nanoscale, Carbon, ACS Applied Materials and Interfaces). He has organized 10-times symposia at E-MRS Spring Meeting, focused on chemical aspects of different carbon materials.

Introductions to the speakers and talks *Back to the Agenda*

Time 15:30-16:00 (UTC/GMT +9, Tokyo) 14:30-15:00 (UTC/GMT +8.00, Beijing) 6:30-7:00 (UTC/GMT 0, London)

Speaker	Hiroshi Kawarada	
Affiliation	Faculty of Science and Engineering, School of Fundamental Science and Engineering, Waseda University, Japan	
Title of the talk	Power & RF Diamond FETs Based on Surface Terminations	

Abstract of the talk

Diamond field effect transistors (FETs) with hydrogen terminated (C-H) diamond surface have been developed by our group from 1994 [1] and exhibited the first RF performance in 2000 [2]. This lateral FET structure still shows best FET performance in high frequency [3] and high voltage application [4] in diamond. Recently, vertical diamond FETs [5] have been also demonstrated for power devices. However, C-H bonds on the surface are inert and refuse any additional chemical bonds to fabricate robust device structure. Although it is acceptable for "labo FET" to show the potential of diamond as electron device, but does not satisfies many industrial requirements. What is an element substitute for H? Oxygen termination provide non conducting surface suitable for device isolation, but not for active FET region such as channel or drift layer. One solution is Si, which preserves sp3 bonds to C as H does, but provides additional chemical bonds for stable films. Recently we have succeeded in forming MOSFETs based on oxidized Si terminated (C-Si-O) diamond as channel. This structure is formed by SiO2 and diamond reaction in reductive and high temperature atmosphere [6, 7] or a few monolayer Si deposition followed by natural oxidation [8]. In the FETs, source and drain are made of ultra-highly doped diamond with 1 x 1022 cm-3 (~5 % atomic density)). The gate oxides are Al2O3 or SiO2. The C-Si-O surface channel is inversion layer and the p channel FETs operate in normally-off operation with large negative threshold voltage beyond -5V [7,8], necessary for power application. Despite of normally-off operation, channel mobility has been measured to be higher than 150 cm2s-1 [7]. Maximum drain current density is above 300 mAmm-1 [8] which is the highest in normally-off diamond FETs. These diamond p-FET performances are comparable to those of SiC or GaN n-FETs and suitable for complementary inverters with high frequency operation.

Introduction to the speaker

Professor Hiroshi Kawarada received Doctor of Engineering from Waseda University (1985) and joined Osaka University as Assistant Professor (1986) where he started diamond research. Later, he worked in Waseda University as Associate Professor (1990) and Professor (1995-), where he developed C-H diamond FET in 1994. As Visiting Researcher he stayed in Fraunhofer Institute (IAF) by Fellowship of Alexander von Humboldt Foundation (1995-1996). As an organizer he served for European Conference on Diamond and Related Materials (1998-2008). In Japan, he also served for Japan Applied Physics Society as Board Member, New Diamond Forum as Chairman (2009-2014) and Science Council of Japan as Member. His research field is nanoelectronics, bioelectronics and power electronics using diamond, where he has 360 articles with 9500 citations.

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Time 16:00-16:30 (UTC/GMT +9, Tokyo) 15:00-15:30 (UTC/GMT +8.00, Beijing) 7:00-7:30 (UTC/GMT 0, London)

Speaker	Jianbo Liang	
Affiliation	Department of Physical Electronics, Osaka Metropolitan University, Japan	
Title of the talk	AlGaN/GaN/3C-SiC-on-diamond high electron mobility transistors (HEMTs) fabrication by diamond room temperature bonding	

Abstract of the talk

AlGaN/GaN high electron mobility transistors (HEMTs) on diamond substrates were fabricated by transferring 4 µm-thick GaN/3C-SiC layers grown on Si templates and subsequently applying the conventional device process steps. No exfoliation of 3C-SiC/diamond bonding interfaces is observed during 800 °C annealing, the essential step for forming ohmic contacts on nitrides. The thermal resistance of HEMTs on diamond is 29 and 47 % of those of HEMTs on Si and SiC, respectively, which is assumed to be the origin of smaller negative drain conductance in on-diamond HEMTs. The thermal boundary conductance (TBC) of the 800°C -annealed interface was determined to be 126 MW/m2·K by time-domain thermoreflectance (TDTR). These results imply that the bonding-first process is applicable for fabricating low-thermal-resistance HEMTs with thick nitride layers.

Introduction to the speaker

Dr. Jianbo Liang is working in Department of Physical Electronics at Osaka Metropolitan University as an associate professor. His research is currently engaged in the direct bonding of diamond and wide band gap semiconductors such as GaN and Ga_2O_3 at room temperature, the bonding interfacial structures, the interface electronical characterization, and the thermal boundary resistance for realizing advanced electronics devices and the devices characterization.

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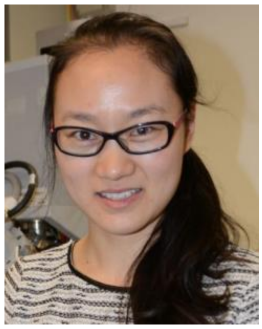
Time 17:00-17:30 (UTC/GMT +9, Tokyo) 16:00-16:30 (UTC/GMT +8.00, Beijing) 8:00-8:30 (UTC/GMT 0, London)

Speaker	Dong Liu	
Affiliation	School of Physics, University of Bristol, UK	
Title of the talk	Real time imaging of the damage and fracture of nuclear-grade graphite at elevated temperatures	

Abstract of the talk

Materials with multiple length-scale structures are a fascinating yet critical class of materials that have characteristic dimensions spanning from nano- to macro-scales. These materials have enormous potential for nuclear and energy applications as they can display unique properties such as combinations of strength and toughness at ambient to elevated temperatures.

Nuclear-grade graphite is a porous graphite composite used as the moderator and major structural component in UK nuclear power reactors. Its 3D microstructure and mechanical properties were acquired by real-time imaging at elevated temperatures (*e.g*., at 1000°C) using synchrotron X-ray computed micro-tomography (XRT). It was found that at reactor operating temperatures, this material has an unusually higher strength and resistance to crack growth than at ambient temperatures. Assisted by other *in situ* techniques such as X-ray/neutron diffraction, Raman spectroscopy and transmission electron microscopy, the physical mechanisms that are responsible for this behaviour relate to the relaxation of residual stresses. In addition, other materials, such as GaN-on-Diamond and silver-diamond composites will be discussed.

Introduction to the speaker

Dr. Dong (Lilly) Liu is currently an Associate Professor at the School of Physics, University of Bristol and Lead of the Materials and Device Theme. She is also Head of the Experimental Mechanics of Advanced Materials group (EMAM).

Her expertise lies in the area of real-time, high temperature multiple-scale microstructural and mechanical characterization of advanced materials such as nuclear carbon/graphite composites, TRISO fuels and ceramic-matrix composites.

Dr. Liu serves on 7 international scientific committees including the ASTM C28.07 Committee (Ceramic Matrix Composites), Composite Materials Handbook Standards (CMH-17) Ceramic Matrix Testing Working Group and the IOM3 Ceramic Science Committee.

She has published a co-authored book (Ritchie & Liu, Introduction to Fracture Mechanics, 2021, Elsevier), a book chapter and >60 journal/conference papers. She has delivered 28 keynote/invited talks at premier international conferences.

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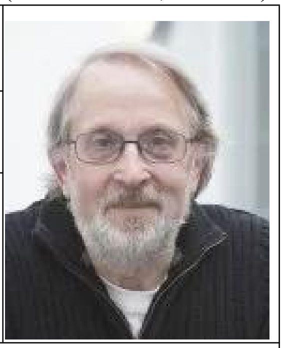
Time 17:30-18:00 (UTC/GMT +9, Tokyo) 16:30-17:00 (UTC/GMT +8.00, Beijing) 8:30-9:00 (UTC/GMT 0, London)

Speaker	Roger Webb	
Affiliation	UK National Ion Beam Centre, University of Surrey, UK	
Title of the talk	Ion Implantation of Diamond	

Abstract of the talk

This talk will give a brief background to the application of ion implantation to diamond substrates. We will explore the various applications of ion implantation with respect to diamond, such as: doping; radiation damage; N-V and Si-V centres for quantum applications; as well the fabrication and growth of diamond via low energy implantation.

Introduction to the speaker

Professor Roger Webb is the Director of the UK National Ion Beam Centre (UKNIBC). The University of Surrey is the lead site of the three University based facilities that make up the UKNIBC. Professor Webb has been working in the field of ion beam surface interactions for more than 45 years and has published more than 275 papers in the field. He has lead the Surrey Ion Beam Centre for the past 15 years and has led the UKNIBC since its creation 5 years ago.

Introductions to the speakers and talks Back to the Agenda

Time 18:00-18:30 (UTC/GMT +9, Tokyo) 17:00-17:30 (UTC/GMT +8.00, Beijing) 9:00-9:30 (UTC/GMT 0, London)

Speaker	Michael Chen
Affiliation	Institute for Bioengineering, School of Engineering, University of Edinburgh, UK
Title of the talk	Diamond nanoneedle arrays for high-throughput intracellular delivery

Abstract of the talk

It is of great importance to introduce foreign materials and molecules into living cells in both cell biology research and gene and cell therapy. The major barrier of intracellular delivery is to cross the cell membrane. To overcome this, a wide variety of biological, chemical and physical approaches have been developed. Here, I present our work of utilizing diamond nanoneedle arrays to facilitate efficient and high-throughput intracellular delivery of fluorescence probes, drugs, nanoparticles and genes. Particularly, this technology has been demonstrated to be able to achieve extremely high transfection efficiency in neurons (~ 45% versus ~ 1-5% of commercial transfection approach). Beyond applications, the biological effects of this technology has also been studied. It is expected that this technique will be very useful in basic cell biology research and also a range of clinical applications.

Introduction to the speaker

Dr Michael Chen received his MSc and PhD from National University of Singapore, and University of Oxford, respectively. He is currently working in the Institute for Bioengineering in the School of Engineering at The University of Edinburgh as a Senior Lecturer in Chemical Engineering. Dr Chen's research is focused on biomaterials, biomedical engineering, and the application of nanomaterials in biology and medicine. In these areas, he has been working on physical (microneedle & nanoneedle arrays), chemical (nanomaterials), and biological (microalgae) tools for drug delivery and sensing. He has published ~ 120 papers in peer-reviewed journals, majority in field top journals such as Advanced Materials, Nature Communications, and Chemical Society Reviews. These publications generated an h-index of 50 and > 6900 citations. Additionally, he has 2 book chapters and 12 granted patents in drug delivery technologies. Some of these technologies have been invested by venture companies for commercialisation.