GUNMA UNIVERSITY

The 11th International Symposium of Gunma University Initiative for Advanced Research (GIAR)

Prospect of the 2D materials for electronic applications

Date

November 24th, 2021 9:30 -12:30 in Japan
November 23rd, 2021 18:30 -21:30 in USA
November 24th, 2021 8:30 -11:30 in Malaysia

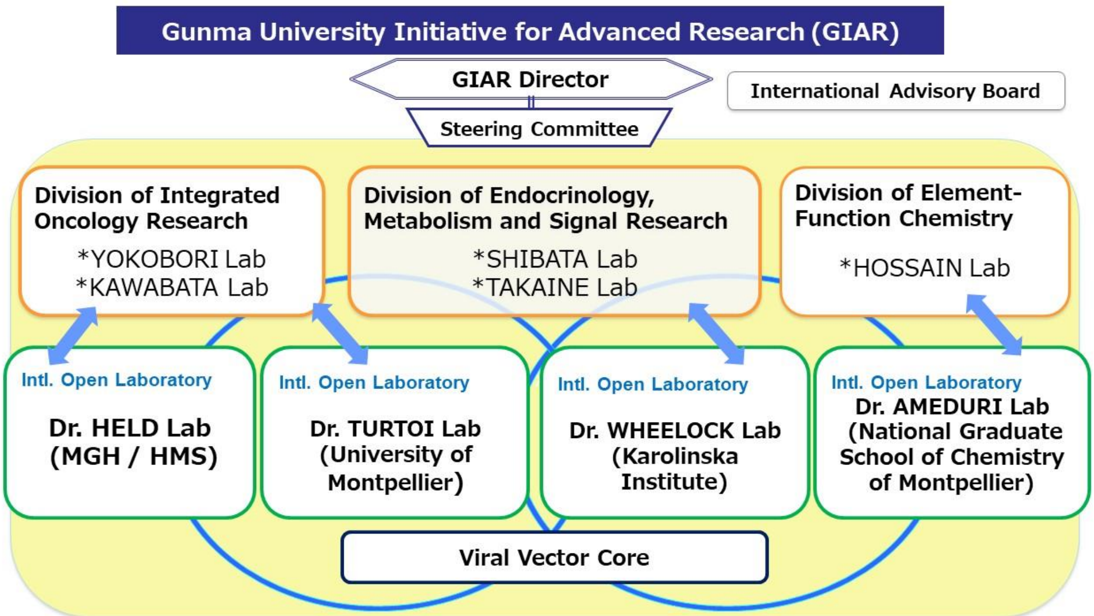
Venue

To be held Online between Japan, USA and Malaysia

About GIAR

“Gunma University Initiative for Advanced Research (GIAR)” was established in 2014 to aim at developing advanced research fields where the university has already great strengths. As the first step, we developed programs for “Integrated Oncology Research” and “Endocrinology, Metabolism and Signal Research”. We also launched international open laboratories at GIAR with top-class overseas researchers to create global research environment. GIAR pursues splendid discoveries for our society and will continue to forge ahead toward our goal of becoming one of the world-leading research institutes.

In April 2019, GIAR was reorganized into three research divisions: “Integrated Oncology Research”, “Endocrinology, Metabolism and Signal Research”, and “Element-Function Chemistry”. Each division collaborates with the international open laboratories and recruits competent young researchers from all over the world. Moreover, in October 2019, “Viral Vector Core” was newly established in GIAR to develop and supply cutting-edge viral vectors as a core hub in this research area in Japan.



WELCOME ADDRESS

9:30 - 9:35 in JST 18:30 - 18:35 in CST 8:30 - 8:35 in MYT	Yasuki Ishizaki (President of Gunma University）

TALK

9:35 - 10:20 in JST 18:35 - 19:20 in CST 8:35 - 9:20 in MYT	Two-Dimensional Neuromorphic Computing Materials and Devices Mark C. Hersam (Northwestern University, USA)
10:20 - 11:05 in JST 19:20 - 20:05 in CST 9:20 - 10:05 in MYT	In-situ observation of surface chemical processes including hydrogen on 2D materials Jun Yoshinobu (ISSP, The University of Tokyo, Japan)
11:05 - 11:50 in JST 20:05 - 20:50 in CST 10:05 - 10:50 in MYT	Development of Chemical Recognition Function for MoS_2 Field-Effect-Transistor (FET) Sensor Tadahiro Komeda (IMRAM, Tohoku University, Japan)
11:50 - 12:25 in JST 20:50 - 21:25 in CST 10:50 - 11:25 in MYT	Graphene FET for Biosensor Applications Ruslinda Binti A. Rahim (INEE, UniMAP, Malaysia)

CLOSING REMARKS

12:25 - 12:30 in JST 21:25 - 21:30 in CST 11:25 - 11:30 in MYT	Minoru Hanaya (GIAR Director Vice President of Gunma University)

Organizer: Md. Zakir Hossain (GIAR, Gunma University)

Mark C. Hersam, Ph.D.
Position: Walter P. Murphy Professor of Materials Science and Engineering
Affiliation: Northwestern University
e-mail address: m-hersam@northwestern.edu

Research Career

Mark C. Hersam is the Walter P. Murphy Professor of Materials Science and Engineering and Director of the Materials Research Center at Northwestern University. He also holds faculty appointments in the Departments of Chemistry, Applied Physics, Medicine, and Electrical Engineering. He earned a B.S. in Electrical Engineering from the University of Illinois at Urbana-Champaign (UIUC) in 1996, M.Phil. in Physics from the University of Cambridge (UK) in 1997, and a Ph.D. in Electrical Engineering from UIUC in 2000. His research interests include nanomaterials, nanomanufacturing, nanoelectronics, scanning probe microscopy, renewable energy, and quantum information science. Dr. Hersam has received several honors including the TMS Robert Lansing Hardy Award, U.S. Science Envoy Fellowship, MacArthur Fellowship, AVS Medard W. Welch Award, and eight Teacher of the Year Awards. An elected member of the National Academy of Inventors, Dr. Hersam has founded two companies, NanoIntegris and Volexion, which are commercial suppliers of nanoelectronic and battery materials, respectively. Dr. Hersam is a Fellow of MRS, ACS, AVS, APS, AAAS, SPIE, and IEEE, and also serves as an Associate Editor of *ACS Nano*.

Talk Title

Two-Dimensional Neuromorphic Computing Materials and Devices

Abstract

The exponentially improving performance of conventional digital computers has slowed in recent years due to the speed and power consumption issues that are largely attributable to the von Neumann bottleneck (i.e., the need to transfer data between spatially separate processor and memory blocks). In contrast, neuromorphic (i.e., brain-like) computing aims to circumvent these limitations by spatially co-locating processor and memory blocks or even combining logic and data storage functions within the same device. In addition to reducing power consumption in conventional computing, neuromorphic devices provide efficient architectures for emerging applications such as image recognition, machine learning, and artificial intelligence. With this motivation in mind, this talk will explore the opportunities for two-dimensional materials in neuromorphic devices. For example, by combining p-type black phosphorus with n-type transition metal dichalcogenides, gate-tunable diodes have been realized, which show anti-ambipolar transfer characteristics that are suitable for artificial neurons, competitive learning, and spiking circuits. In addition, by exploiting field-driven defect motion mediated by grain boundaries in monolayer MoS_2, gate-tunable memristive phenomena have been achieved, which enable hybrid memristor/transistor devices (i.e., 'memtransistors') that concurrently provide logic and data storage functions. The planar geometry of memtransistors further allows multiple contacts to the channel region that mimic the behavior of biological neurons such as heterosynaptic responses and continuous learning. Overall, this work introduces new foundational circuit elements for neuromorphic computing in addition to providing alternative pathways for studying and utilizing the unique quantum characteristics of two-dimensional materials.

Jun Yoshinobu, Dr. Sci.
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Research Career

1989: Dr. of Science, Kyoto University
1989-1991: Postdoc, Pittsburgh Univ.
1991-1992: Postdoc. RIKEN
1991-1997: Researcher, RIKEN
1997-2007: Assoc. Prof., ISSP, Univ. of Tokyo
2007- present: Prof., ISSP, Univ. of Tokyo

Talk Title

In-situ observation of surface chemical processes including hydrogen on 2D materials

Abstract

There has been a growing interest in the functionalities and reactions on two-dimensional materials including graphene and transition-metal dichalcogenides (TMDs). In this talk, I will present two topics from our recent research activities.

(1) Scalable and rapid production of graphene is required for its industrial applications. Chemical vapor deposition (CVD) is one of the promising methods to synthesize large-area single-crystalline graphene. In a typical CVD process of graphene, gaseous CH_4 with Ar and H_2 is supplied onto a Cu substrate at a temperature of about 1000 °C, where CH_4 molecules are decomposed to form the nucleus of graphene. Here, we used radiation-mode optical microscopy (Rad-OM), which can visualize graphene growth in real time by utilizing the difference in the emissivity between graphene and Cu. Furthermore, we combined the Rad-OM with *in-situ* synchrotron radiation XPS (SR-XPS) to characterize surface species and elucidate the effect of hydrogen.

(2) Molybdenum disulfide (MoS_2) is one of the TMDs and has a layered structure. Monolayer or a few layer MoS_2 is expected to have various applications such as field-effect-transistors, optoelectronic devices, and gas sensors. On the other hand, MoS_2 has been used as catalysts for many years. In this work, we have investigated the interaction of molecular hydrogen on the Pd/MoS_2 surface using ambient-pressure (AP) XPS under hydrogen atmosphere. Comparing the case of an inert MoS_2 bare surface, we found that the Pd-deposited MoS_2 basal surface has higher activity for the dissociation of hydrogen molecules. Based on the XPS results, we confirmed that the active site for dissociation of molecular hydrogen is ascribed to deposited Pd atoms, and the electronic states of the MoS_2 substrate have been modulated by hydrogen atoms spilled over onto the MoS_2 surface.

Tadahiro Komeda, Ph.D.
Position: Professor
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Research Career

Tadahiro Komeda received a bachelor's degree and a PhD from Kyoto University, Japan. His thesis theme is the angle resolved photoemission spectroscopy for adsorbed molecules on metal surfaces. He was a post-doctoral fellow with Prof. John H. Weaver at University of Minnesota. After working as a research staff in Texas Instruments, he jointed Riken, Japan, starting low temperature STM for the studies of 'nano chemistry' using tunneling electrons. He joined Tohoku University as a full professor at 2003. His research group works on developing chemical-analysis techniques for molecular electronic and spintronic device materials to enable a single molecule characterization using scanning probe microscopes.

Talk Title

Development of Chemical Recognition Function for MoS_2 Field-Effect-Transistor (FET) Sensor

Abstract

Miniaturized sensor,that is suitable to operate with an in vivo condition, has attracted great demand for past decades. For such an application field-effect-transistor (FET) sensor with using the atomically thin MoS_2 channel material can be a promising candidate. Due to the atomic thin layer, MoS2 channel can be more sensitive to the adsorption of different organic molecules when it is used in FET. Molecular identification using FET devices has been performed by the drain current change that can be attributed to the charge exchange or the polarization of molecules. This technique however has no significant chemical sensitivity to the molecules. In this talk, utilizing the MoS2-FET devices, molecule sensor has been developed that has the chemical recognition capability. Visible light was injected onto the deposited channel and molecular identification was observed by the electronic property of the FET. In addition, π-electron molecules that have the broad band photo response properties such as phthalocyanine, methylene blue, di-carbocyanine iodide and many more organic molecules were used as adsorbates for MoS_2 channel and detected by light injection.

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Research Career

Ruslinda binti A. Rahim received the Doctor of Philosophy (Ph.D) majoring in Nanoscience and Nanoengineering from Waseda University, Japan in September 2012. She also received M. Eng and B. Eng degree in Electrical and Electronic Engineering from Muroran Institute of Technology, Japan in 2007 and 2002, respectively. Currently, she is a Director of National Nanotechnology Centre under Ministry of Science, Technology and Innovation (MOSTI). She also a Research Fellow in Institute of Nano Electronic Engineering (INEE), Universiti Malaysia Perlis (UniMAP) and Associate Research Fellow in Institute of Microengineering and Nanoelectronics (IMEN), The National University of Malaysia (UKM). Her research interests include Nanoelectronics, Nanostructure device, Biosensors, Bioelectronics, DNA and protein detection, Aptamer and surface chemistry on carbon-based materials. She also active in several societies such as a Board of Engineers Malaysia, Professional Technologist Malaysia (MBOT) (Nanotechnology), Committee member of Malaysia Nanotechnology Association, Board of Member Malaysia Sensor Society and Editor of the International Journal of Nanoelectronics and Materials.

Talk Title

Graphene FET for Biosensor Applications

Abstract

Field-effect transistors (FETs) have succeeded in modern electronics in an era of computers and hand-held applications. Currently, considerable attention has been paid to direct electrical measurements, which work by monitoring changes in intrinsic electrical properties. Further, FET-based sensing systems drastically reduce cost, mass production capability, fast-result and ease down-stream applications such as biosensor.
Graphene is a unique two-dimensional material with its spectacular structural and electronic properties that has appealed towards the sensing material due to its high electron mobility, transparency and mechanical strength. In this work, current technologies for sensing applications is presented specifically focus on high-performance FET-based sensor integration with nano-sized materials, which requires understanding the interaction of surface materials with the surrounding environment.

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