GRAPHENE FLAGSHIP

CHINA ACADEMY OF SCIENCES

Workshop Report

The Third Graphene Flagship EU-China Workshop on Graphene and Related 2D Materials

Shanghai, China 16-18 October 2019

Workshop chairs: Xinliang Feng (Germany), Hongjue Gao (China), Jari Kinaret (Sweden), Xiaoming Xie (China)

Programme chairs: Xinliang Feng (Germany), Qingkai Yu (China), Shixuan Du (China), Francesco Bonaccorso (Italy)

Contents

Overview

The 3rd Graphene Flagship EU-China Workshop on Graphene and related 2D materials was held on 16-18 October 2019 at Shanghai Institute of Microsystem and Information System (CAS), Shanghai, China.

The workshop aimed at being a forum for the exchange of experiences, practices and ideas related to the current and emerging topics associated with the fundamental materials synthesis, physics and devices for graphene and related 2D materials. In addition, the objective was to explore further possibilities for collaborative research opportunities between researchers in Europe and China.

This was a follow up of the China-EU Workshop held in Dresden, Germany, on 07-08 December 2018.

The workshop gathered 27 participants (16 from China and 11 from Europe), coming mainly from academic institutions. Speakers gave 26 talks that have shown the breadth of activities and topics covered by their respective research groups. The selection of the scientific speakers and participants was done by the two groups of organizers. All presentations stimulated questions and discussions. Several Graphene Flagship work-packages (Enabling Research, Spintronics, Photonics and Optoelectronics, Energy Generation, Functional Foams & Coatings, Innovation, Management) and leading Chinese institutions active in graphene and related materials (GRM) research were represented at the meeting which offered a unique opportunity for direct exchanges and development of new collaborations.

The workshop was opened by Prof. Feng and Prof. Gao who set the scene and introduced the overall goals for the meeting. Prof. Kinaret presented the status of the Graphene Flagship. Prof. Xie, a workshop chair from China, highlighted the progress in the past two years in China and major opportunities for research support available in China. The Chinese government and industry are ambitious on the fundamental research and application of graphene in the coming few years. It is expected that at least a billion of CNY (> 120M Euro) over 5 years. This available funding will continue support the research in the field of 2D materials but will also allow to set-up new collaborations and opportunities.

Common challenges and opportunities for collaborations

In the final discussion session, participants identified the areas of key issues and common interest that include mainly fundament science of GRM growth, heterostructures, energy, devices and physics. Both sides of EU and China showed the great interests in fundamental and application of GRM. EU and China may have the opportunity to collaborate in the field of graphene growth (especially in the study of the growth mechanism) and energy application.

At the end of the meeting, there was clear interest to continue the series of workshops by organising the next workshop again in Strasbourg, France, possibly in September 2020 (around Graphene Week).

Both sides have been trying to boost the further collaboration between each other. However, up to now, the collaboration is still limited in several groups, but not extended to a large body size. Both sides agreed to find new approaches for the collaboration beyond current stages.

Some of the topics suggested by the participants were:

- Materials mechanism, synthesis and characterisation;
- Artificial intelligence for new materials;
- Energy application;
- Heterojunctions.

Both sides agreed that the collaboration should be further propelled for coming year.

Programme

October 16, 2019		
18:00 Welcome dinner at PentaHotel Shanghai		
October 17, 2019		
08:30 – 08:45	**Registration and welcome**	
08:45 – 08:55	*Xiaoming Xie*	Welcome Words and opening workshop
08:55 – 09:05	*Hongjun Gao*	Graphene and 2D Materials activities in China
09:05 – 09:15	*Jari Kinaret*	Graphene Flagship
Session 1: Materials Growth and Heterostructures *Chair: Xinliang Feng*		
09:15 – 09:40	*Yunqi Liu*	Controllable growth and performance modulation of graphene
09:40 – 10:05	*Stephan Hofmann*	Crystal Growth in the Flatland: Growth Mechanisms in 2D Materials and Pathways to Scalable, Controlled Device Integration
10:05 – 10:30	*Wencai Ren*	Graphene films: Controlled synthesis and applications
10:30 – 10:55	*Yangfeng Zhang*	Wafer Scale Syntheses and application explorations of Transitional Metal Dichalcogenides
10:55 – 11:15	**Coffee Break**	
Session 2: Materials Growth *Chair: Shixuan Du*		
11:15 – 11:40	*Qingkai Yu*	CVD synthesis of graphene single crystal and wafer
11:40 – 12:05	*Artur Ciesielski*	2d materials via liquid-phase exfoliation
12:05 – 12:30	*Yeliang Wang*	Controllable Growth and Properties of VSe2 monolayer and 1D-patterned Superstructures
12:30 – 13:45	**Lunch**	
Session 3: Device and Application *Chair: Francesco Bonaccorso*		
13:45 – 14:10	*Wanlin Guo*	From interface interactions of 2D heterostructures to devices
14:10 – 14:35	*Haomin Wang*	Synthesis of graphene nanoribbon
14:35 – 15:00	*Georg S. Duesberg*	Applications of Nobel Metal Dichalcogenides in Electronics
15:00 – 15:25	*Gianluca Fiori*	Two-dimensional materials and their applications in electronics
15:25– 15:55	**Coffee Break**	
Session 4: Device and Application *Chair: Qingkai Yu*		
15:55 – 16:20	*Xinliang Feng*	Organic 2D Materials for Electronics
16:20 – 16:45	*Peter Bøggild*	Patterning of graphene on 10 nm scale for bandgap engineering

16:45 – 17:10	*Jose A Garrido*	Graphene technologies: new tools in neuroscience
17:10 – 17:20	Wrap-up of the first day	
17:20 – 22:00	***Visiting Shanghai River Side with dinner***	

October 18, 2019		
Session 5: Energy and Application *Chair: Yuanbo Zhang*		
09:00 – 09:25	*Mar García Hernandez*	Material Science at the Flagship Graphene
09:25 – 09:50	*Francesco Bonaccorso*	Energy applications: New routes enabled by 2D materials
09:50 – 10:15	*Qiang Fu*	Operando surface and interface analysis of battery processes in model electrodes based on two-dimensional materials
10:15 – 10:40	*Xiaodong Zhuang*	2D materials synthesis and energy storage
10:40 – 11:00	**Coffee Break**	
Session 6: Physics *Chair: Pingheng Tan*		
11:00 – 11:25	*Yuanbo Zhang*	Magnetic-field-induced quantized anomalous Hall effect in intrinsic magnetic topological insulator MnBi2Te4
11:25 – 11:50	*Qing Dai*	Freestanding Graphene Plasmon
11:50 – 12:15	*Kaihui Wu*	Borophene
12:15– 13:30	**Lunch**	
Session 7: device and simulation *Chair: Peter Bøggild*		
13:30 – 13:55	*Pingheng Tan*	Cross-dimensional Electron-phonon coupling in van der Waals heterostructures
13:55 – 14:20	*Shixuan Du*	Computational design and physical properties of low dimensional nanostructures
14:20 – 14:45	*Heng Fan*	Quantum simulation by superconducting quantum circuits
14:45 – 15:30	**Discussions on future collaborations** *Chair: Francesco Bonaccorso*	
15:30	*Xinliang Feng*	**End of the workshop**

Participants list

Prof.	Peter	Bøggild	Technical University of Denmark	Denmark
Dr.	Francesco	Bonaccorso	Graphene Labs, Italian Institute of Technology	Italy
Prof.	Georg	Düsberg	Universität der Bundeswehr München	Germany
Prof.	Xinliang	Feng	TU Dresden	Germany
Prof.	Gianluca	Fiori	University of Pisa	Italy
Prof.	Mar	Garcia Hernandez	CSIS	Spain
Prof.	Jose	Garrido	Catalan Institute of Nanoscience and Nanotechnology (ICN2), The Barcelona Institute of Science and Technology (BIST)	Spain
Prof.	Stefan	Hofmann	Department of Engineering, Cambridge University	United Kingdom
Prof.	Jari	Kinaret	Chalmers University of technology	Sweden
Prof.	Hongjun	Gao	Institute of Physics, CAS	China
Prof.	Shixuan	Du	Institute of Physics, CAS	China
Prof.	Haomin	Wang	Shanghai Institute of Microsystem and Information Technology	China
Prof.	Xiaoming	Xie	Shanghai Institute of Microsystem and Information Technology	China
Prof.	Wencai	Ren	Institute of Metal Research, CAS	China
Prof.	Cinzia	Casiraghi	University of Manchester	United Kingdom
Prof.	Yanfeng	Zhang	Peking University	China
Prof.	Heng	Fan	Institute of Physics, CAS	China
Prof.	Yeliang	Wang	Institute of Physics, CAS	China
Dr.	Artur	Ciesielski	Université de Strasbourg & CNRS	France
Prof.	Qing	Dai	National Centre of Nanoscience and Technology	China
Prof.	Wanlin	Guo	Nanjing University of Aeronautics and Astronautics	China
Prof	Kaihui	Wu	Institute of Physics, CAS	China
Prof	Pingheng	Tan	Institute of Semiconductors, CAS	China
Prof	Yuanbo	Zhang	Fudan University	China
Prof	Xiaodong	Zhuang	Shanghai Jiaotong University	China

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Book of abstracts

Peter Bøggild

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Title of the presentation：
Patterning of graphene on 10 nm scale for bandgap engineering

Abstract：

In theory, nanostructuring of graphene opens for the electronic bandgap and thus electronic and optical properties to be engineered to match specific applications or to expose entirely new physics. In practice, even low levels of edge disorder and contamination associated with even the finest lithographic processes, have shown to ruin the expected performance. Disorder makes it very difficult to achieve the predicted quantum transport properties as well as downscaling graphene electronic components comparable mainstream silicon electronics. I will discuss progress in engineering the graphene edges[1,2], and focus on a recent example [3]. We show that by combining encapsulation in hexagonal boron nitride with high-density electron beam lithography, a carefully tuned etching process allows us to pattern graphene on the 10 nm scale (Fig. 1), and still preserve the detailed magnetotransport signatures predicted by tight-binding calculations. In addition, the surprising survival of the subtle moire-superlattice signatures associated with twisting of the crystalline

interlayers opens for construction of circuits and components that exploit this emerging branch of solid-state physics. I will also briefly discuss recent progress made in making growth of large scale 2D materials, transfer and electrical characterisation cleaner, faster and easier.

J. M. Caridad, G Calogero, P Pedrinazzi, J E Santos, A Impellizzeri, T Gunst, T J Booth, R Sordan, P Bøggild, M Brandbyge, A graphene-edge ferroelectric molecular switch, Nano Letters, 18, 8, 4675-4683 (2018)

J. M. Caridad, S. R. Power, M. R. Lotz, A. Shylau, J. D. Thomsen, L. Gammelgaard, T. J. Booth, A-P Jauho, P. Bøggild, Conductance quantization suppression in the quantum Hall regime, Nature Communications, 9:659 (2018)

B. S. Jessen, L. Gammelgaard, M. R. Thomsen, D. M. A. Mackenzie, J. D. Thomsen, J. M. Caridad, E. Duegaard, K. Watanabe, T. Taniguchi, T. J. Booth, T. G. Pedersen, A-P. Jauho, P. Bøggild, Nature Nanotechnology, 2019, 10.1038/s41565-019-0376-3

Francesco Bonaccorso

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Title of the presentation：
Energy applications: New routes enabled by 2D materials

Abstract：

Two-dimensional (2D) materials are entering several application areas,[1-5] improving the performance of existing devices or enable new ones.[1-5] A key requirement for the implementation of 2D materials in the energy field is the development of industrial-scale, reliable, inexpensive production processes,[2] while providing a balance between ease of fabrication and final product quality.

In this context, the production of 2D materials by solution processing[2,6] represents a simple and cost-effective pathway towards the development of 2D materials-based energy devices, presenting huge integration flexibility compared to other production methods. Here, I will first present our strategy to produce 2D materials on large scale by wet-jet milling[7] of their bulk counterpart and then an overview of their applications for energy devices.[3,8-15]

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[2] F. Bonaccorso, et al., Materials Today, 15, 564-589, (2012).
[3] F. Bonaccorso, et. al., Nature Photonics 4, 611-622, (2010).
[4] F. Bonaccorso, Z. Sun, Opt. Mater. Express 4, 63-78 (2014).
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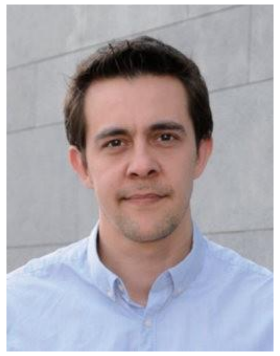
[14] L. Najafi, et al. ACS Nano 12, 10736 (2018).
[15] S. Bellani et al., Advanced Functional Materials 29, 1807659 (2019).

Biography：

Francesco Bonaccorso gained the PhD from the University of Messina in Italy after working at the Italian National Research Council, the Engineering Department of Cambridge University (UK) and the Department of Physics and Astronomy of Vanderbilt University (USA). In June 2009 he was awarded a Royal Society Newton International Fellowship at Cambridge University, and elected to a Research Fellowship at Hughes Hall, Cambridge, where he also obtained a MA. He is currently leading the processing and prototyping group at the Istituto Italiano di Tecnologia (IIT), Graphene Labs. He was responsible in defining the ten years scientific and technological roadmap for the European Graphene Flagship. He is now Deputy of the workpackage Innovation of the Flagship. He was featured as Emerging Investigator in 2016 by J. Mater. Chem. A and in 2019 by ChemPlusChem. His research interests encompass both the fundamental understanding and solution processing of novel nanomaterials with on-demand designed structures, their spectroscopic characteriza tion, incorporation into polymer composites and their technological application in solar and photoelectrochemical cells, lithium-ion batteries, light emitting devices and ultrafast lasers. He organized several conferences such as Graphene2015/2016/2017/2018/2019, Graphene Canada, GrapChina 2014/2015/2016/2017/2018/2019 etc., and symposia in MRS, e-MRS. He has several publications in journals such as Science, Nature Nanotechnology, Nature Photonics, Chemical Society Reviews, Advanced Materials, Nano Letters, etc.. These have been covered by a number of reports in the technical and general press. He Co-founded two start-up, i.e., Cambridge Graphene Ltd and BeDimensional Spa, a Spin-off of IIT.

Guest introduction



Artur Ciesielski

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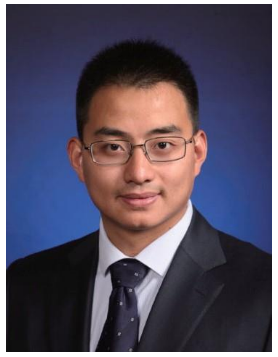
Title of the presentation：
2D materials via liquid-phase exfoliation

Abstract：
Two-dimensional (2D) materials (2DMs), which can be produced by exfoliating bulk crystals of layered materials, display unique optical and electrical properties making them attractive components for a wide range of technological applications. In this context, attaining a full control over the generation of high-quality 2DMs with methods that can be employed for large-scale production of exfoliated nanosheets and inks thereof represents a major challenge of potential technological interest in the numerous fields, even beyond opto-electronics and sensing, such as those associated to energy applica-tions. During this lecture the most recent developments in the production of high-quality 2DMs based inks using liquid-phase exfoliation (LPE) will be discussed, combined with the patterning approaches, highlighting convenient and effective methods for generating materials with controlled thicknesses down to the atomic scale.
Different processing strategies which can be employed to deposit the produced inks as patterns and functional thin-films will be introduced, by focussing on those that can be easily translated to the industrial scale such as coating, spraying and various printing technologies. By providing insight into the multiscale analyses of numerous physical and chemical properties of these functional films and patterns, with a specific focus on their extraordinary electronic characteristics, this lecture will offer crucial information for a profound understanding of the fundamental properties of these patterned surfaces as the millstone towards the generation of novel multifunctional devices.

Biography：
Dr. Artur Ciesielski is a research associate (IR) working at the Institut de Science et d'Ingénierie Supramoléculaires and Centre National de la Recherche Scientifique in Strasbourg (France). More recently, he has been appointed as a visiting professor at the Centre for Advanced Technologies of Adam Mickiewicz University (Poznań, Poland). His current research interests include the design of supramolecular systems, the self-assembly of nanopatterns and the production and chem-ical modification of 2D materials by exploiting supramolecular approaches. Recently he has been extremely active in the development graphene and related 2D materials by mild (liquid-base) approaches and at their use, once functionalized with ad hoc molecules, as functional foams and coatings for sensing and for water purification and sensing.



Qing Dai

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Title of the presentation：
Freestanding Graphene Plasmon

Biography：
Dr. Qing Dai is a professor in Nanophotonics at National Center for Nanoscience and Technology (NCNST), China. He received his MEng degree on Electronic & Electrical Engineering from Imperial College, London, before coming to the University of Cambridge to pursue a PhD in Nanophotonics at the Department of Engineering. After completing his PhD in 2011, Qing was elected as Junior Research Fellow at Wolfson College and continued as a Research Associate at Centre for Advanced Photonics and Electronics (CAPE).

He received the award from the thousand talents program of China in 2012 and joined NCNST. He has published over 60 peer-reviewed papers in reputed international journals (including Nature Communications, Nanoscale, Advanced materi als). He is a regular reviewer of various high-impact journals (such as Nature Materials, Nanoscale).

Georg S. Duesberg

Institute/Company： UniBw M Universität der Bundeswehr München **Affiliation：** Institute of Physics, EIT 2 Faculty of Electrical Engineering and Informa- tion Technology

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Title of the presentation：
Applications of Nobel Metal Dichalcogenides in Electronics

Abstract：

Two-dimensional materials such as transition metal dichalcogenides (TMDs) are intensively investigated because of their potential applications in future electronics. In particular the integration of TMDs with Si-based technology is highly sought. So far mainly group six (Mo/W) TMDs have been investigated, which show thickness depend electronic and optical properties. Metal-to-semiconductor transitions, high mobilities, and high potential for various sensing applications, now raised interest to the group 10 (Pt/Pd) TMDs or Nobel Metal Dichalcogenides (NMDs).

In this presentation, the low temperature synthesis of various TMDs by thermally assisted conversion (TAC) is presented. [1] The composition and morphology of the resulting large-scale layers are analysed by Raman spectroscopy, [2] AFM and X-ray photoelectron spectroscopy. In particular, the low temperature TAC synthesis PtSe2 potentially allows back end of line (BEOL) integration compatible with silicon technology. The effects of growth on the underlying substrates or investi- gated by TOF-SIMS and XPS depth-profiles as well as transmission electron microscopy (TEM). Further, as pre-pattered structures can be grown by the TAC, which allows to fabricate electronic devices using standard micro-fabrication technology. [3] In particular, PtSe2 has shown potential for novel sensors. Examples for high performance chemical sensors, [1] IR-photodetectors[4] and MEMS[5] devices with PtSe2 will be presented.

References:

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[4] Yim, et al. Nano Letters, 3 (18), 1794 2018
[5] Wagner et al. Nano Letters, 8 (6), 3738 2018

Biography：

Prof. Georg S. Duesberg has the Chair for Sensortechnologies at the Universität der Bundeswehr, Munich. Georg S. Dues- berg graduated in Physical Chemistry from the University of Kassel, Germany in 1996. He gained his PhD at Max-Planck-Institute for Solid State Research, Stuttgart from 1997 – 2001. From 2001 – 2005 he worked at the Infineon AG, in the Corporate Research Department in Munich, followed by two years in the Thin Films Department at Qimonda AG, Dresden. In 2007 Georg Duesberg became Assoc. Prof. in the School of Chemistry of Trinity College Dublin, Ireland and a Principal Investigator in at the Irish National Research Institute CRANN. In 2017 Prof. Duesberg moved to the Institute of Physics at the UniBW M in Munich. He has co-authored more than 240 publications with more than 28000/15000 citations (H-index 72/60,Google/Reuters) and has filed more than 25 patents. His research focuses on the synthesis, characterization and devices integration of low-dimensional structures.

Heng Fan

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Title of the presentation：
Quantum simulation by superconducting quantum circuits

Abstract：

Superconducting quantum circuits are promising for simulation of various physical phenomena. In this talk, I will present our recent results about quantum simulation and entanglement generation. We realize the strongly correlated quantum walks in a 1D array of 12-qubit superconducting quantum processor. The one- and two-particle quantum walks are realized by time evolution of quantum states by flipping one qubit or two qubits after initialization. For one-particle quan- tum walks, the propagations of quantum information including entanglement are shown precisely. We can find that the propagations of different physical quantities can be described by Lieb-Robinson bounds which are analogous to light-cone phenomenon. The anti-bunching is shown in two-particle quantum walks due to strongly correlated excitations. Results about simulation of localizations for a Bose-Hubbard ladder model by 20 superconducting qubits, generation of 20-qubit Schrodinger cat states and 18-qubit GHZ state with superconducting qubits will be presented.

References:

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[2] Z. Yan et al., Science 364, 753-756 (2019).
[3] Y. Ye et al., Phys. Rev. Lett. 123, 050502 (2019).

Biography：

Heng Fan is a Professor in Institute of Physics, Chinese Academy of Sciences. His current research focus on quantum computation, quantum simulation by superconducting quantum circuits. He has more than 260 publications including 2 papers in Science, 2 in Physics Reports and 15 papers in Nature Commun. PRL/X. His present research topics are simula- tion of various phenomena associated with many-body condensed matter physics.

Guest introduction

Xinliang Feng

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Title of the presentation :
Organic 2D Materials for Electronics

Abstract :
In the past decade, as inspired by the discovery of graphene, two-dimensional (2D) materials which possess a periodic network structure and with a topographical thickness of atomic/molecular level, have emerged as the new paradigm of materials with enormous potentials, ranging from electronics and optoelectronics to energy technology, membrane, sensing and biomedical applications. Various fabrication strategies have been developed to attain high quality 2D materi- als. Among of them, mechanical exfoliation remains the most popular protocol to isolate single-layer high quality 2D materials for fundamental physical studies.
In contrast to the tremendous exploration of graphene and inorganic 2D materials such as metal dichalcogenides, boron nitride, black phosphorus, metal oxides and nitrides, the study on organic 2D material systems including the bottom-up organic synthesis of graphene nanoribbons, 2D metal-organic frameworks, 2D polymers/supramolecular polymers as well as supramolecular approach to 2D organic nanostructures remains under development. In this lecture, we will present our recent efforts on the bottom-up synthetic approaches towards novel crystalline organic 2D materials with structural control at the atomic/molecular-level. 2D conjugated polymers and coordination polymers thus belong to such materials classes. The unique structures with possible tailoring of conjugated building block and conjugation length, adjustable pore size and thickness, as well as interesting electronic structure make them highly promising for a number of applications in electronics and spintronics.

Biography :
Prof. Feng is a full professor and the head of the Chair of Molecular Functional Materials at Technische Universität Dresden. He has published more than 460 research articles which have attracted more than 51000 citations with H-index of 108 (Google Scholar). He has been awarded several prestigious prizes such as IUPAC Prize for Young Chemists (2009), European Research Council (ERC) Starting Grant Award (2012), Journal of Materials Chemistry Lectureship Award (2013), ChemComm Emerging Investigator Lectureship (2014), Fellow of the Royal Society of Chemistry (FRSC, 2014), Highly Cited Researcher (Thomson Reuters, 2014-2018), Small Young Innovator Award (2017), Hamburg Science Award (2017), EU-40 Materials Prize (2018), ERC Consolidator Grant Award (2018), member of the European Academy of Sciences (2019) and member of the Academia Europaea (2019). He is an Advisory Board Member for Advanced Materials, Chemical Science, Journal of Materials Chemistry A, ChemNanoMat, Energy Storage Materials, Small Methods, Chemistry -An Asian Journal, Trends in Chemistry, etc. He is the Head of ESF Young Research Group "Graphene Center Dresden", and Working Package Leader of WP Functional Foams & Coatings for the European Commission's pilot project "Graphene Flagship".

Gianluca Fiori

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Title of the presentation :
Two-dimensional materials and their applications in electronics

Abstract :
In this talk, I will try to give some perspectives regarding the applications where two-dimensional materials could repre- sent an enabling technology for new applications in the electronic field, while assessing their ultimate performance through numerical simulations.

I will also address the topic of printable electronics, since 2DMs have recently demonstrated their potential to obtain deposited materials through inkjet technique, with insulating, semiconducting and metallic properties, that are the main ingredients to obtain printed electronic devices. The ability to stack them one on top of the other forming heterostruc- tures, is an adding additional degree of freedom, that could pave the way towards working devices for medium-scale level of integration.

Biography :
Gianluca Fiori is Professor of Electrical Engineering at Universita` di Pisa, Pisa, Italy. In autumn 2002, he visited Silvaco International, developing quantum models, which are currently implemented in the commercial simulator Atlas by Silvaco. In summers 2004, 2005, and 2008, he visited Purdue University, West Lafayette, IN, USA, where he worked on models for the simulation of transport in nanoscaled devices. His main field of activity includes the development of models and codes for the simulations of ultrascaled semiconductor devices, with particular focus on two-dimensional materials based transistors. G.F. is the leading developer of the open-source code NanoTCAD ViDES (http://vides.nanotcad.com).

Recently, he is spending efforts towards the characterization and fabrication of printed electronic devices through two- dimensional materials.
More information available at http://gianlucafiori.org

Guest introduction

Qiang Fu

Institute/Company： Dalian Institute of Chemical Physics, CAS
Affiliation： Dalian Institute of Chemical Physics, CAS **Email**
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Title of the presentation：
Graphene technologies: new tools in neuroscience

Abstract：
Traditional photoemission spectroscopy and electron microscopy methods including X-ray photoelectron spectroscopy (XPS) and photoemission electron microscopy (PEEM) are based on ultrahigh vacuum conditions. Near ambient pressure (NAP) XPS and NAP-PEEM have been developed and built in our lab in order to investigate surface and interface process-es in energy and catalysis close to the real reaction conditions. Two-dimensional (2D) nanoreactor formed under 2D materials can provide a well-defined model system to explore confined catalysis and energy processes using the NAP surface science techniques. Particularly, the interlayer within 2D materials provides 2D space for ion diffusion and intercalation, which is the fundamental step of the secondary ion batteries. Here, Al-ion battery processes under the 2D materials have been dynamically visualized by operando-Raman, operando-XPS, electrochemical atom force microscopy (AFM), and others. The charging mechanism and surface effect in the battery process have been revealed.

Biography：
Qiang Fu obtained his B.S. in 1996 from Beijing Institute of Technology and his Ph.D. in 2000 from the same university. Afterwards, he joined Max Planck Institute for Metal Research in Stuttgart for his postdoctoral studies. In 2005, he moved to Fritz Haber Institute of the Max Planck Society. In 2006, he took a position in Dalian Institute of Chemical Physics CAS and became a full professor in 2008. He is leading a group working on surface and interface catalysis and acts as deputy director of the State Key Lab of Catalysis. His main research interest includes surface and interface catalysis, surface and interface electrochemistry, and development of new surface characterization techniques.

Mar Garcia-Hernandez

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Title of the presentation：
Material Science at the Flagship Graphene

Abstract：
Since the beginning of the flagship, WP3 Enabling Materials has played a very important role in the development of scalable synthesis methods of 2D materials and in supplying tailored materials for a range of applications across the flagship. Some of the most representative synthetic methods developed and highlights developed will be briefly reviewed. Among them are those related to liquid phase exfoliation, CVD, SiC sublimation, bottom up synthesis of GNRs.

We will mention the ways of working that have enabled a strong interaction of the WP Enabling Materials with other WPs and the contribution to important flagship targets as the standardization of graphene or the setting of materials data base.

Biography：
Mar Garcia-Hernandez is Research Professor at CSIC. Her research has focused on complex oxide 2D heterostructures with application in spintronics, fundamental problems regarding diluted magnetic semiconductors and superconductors. Currently, she is deeply involved in the synthesis and functionalization of 2D layered materials. She has co-authored more than 280 publications in peer reviewed journals. She leads the Material Science WP and is a member of the Executive Board of the Graphene Flagship. She is the Scientific Director of the nation-wide Archimedes scientific contest that promotes research among undergraduate and master students in Spain and is deeply involved in outreach activities. She has been awarded the Innovative Enterprises Forum Prize for The Innovative Researcher of the year (2018) and the Scien- tist of the year by the Spanish Scientist Association. She has been member of the Women at CSIC Committee and is an active member of the group "Women in Graphene". From January 2019 she is vice-Chancellor of the Universidad Interna- cional Menendez y Pelayo.

Guest introduction

Jose A Garrido

Institute/Company：Catalan Institute of Nanoscience and Nanotechnology
Affiliation：Catalan Institute of Nanoscience and Nanotechnology & ICREA
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Title of the presentation：
Graphene technologies: new tools in neuroscience

Abstract：
Stablishing a reliable bidirectional communication interface between the nervous system and electronic devices is crucial for exploiting the full potential of neural prostheses. Despite recent advancements, current technologies evidence important shortcomings, e.g. low signal-to-noise ratio for signal mapping, low charge injection capacity for nerve stimulation, poor long-term stability, challenging high density integration, etc. Thus, efforts to explore novel materials are essential for the development of next-generation neural prostheses. Graphene and graphene-based materials possess a rather exclusive set of physicochemical properties holding great potential for biomedical applications, in particular neural prostheses. This presentation will provide an overview on fundamentals and applications of several graphene-based technologies and devices aiming at developing an efficient bidirectional communication with the nervous system. In this respect, the presentation will review recent technology developments exploring the capability of graphene-based devices for recording and stimulating electrical activity in the central and peripheral nervous systems. The main goal of this talk is to discuss the potential of graphene technologies in the field of neural interfaces and prostheses, and at the same time to identify the main challenges ahead.

Biography：
J. A. Garrido is an ICREA Professor since 2015, when he joined the Catalan Institute of Nanoscience and Nanotechnology (ICN2) in Barcelona after 15 years at the Physics Department of the Technische Universität München, Germany. He has a PhD on Telecommunication Engineering by Universidad Politécnica de Madrid and a Habilitation degree by the TU München. He has pioneered the use of 2D materials such as graphene for application in biosensing, bioelectronics, and neural implants. He leads several EU and Spanish projects aimed at developing neural interfaces for bidirectional commu- nication with the nervous systems. He is deputy leader of the workpackage Biomedical Technologies of the Graphene Flagship and coordinator of BrainCom, an EU project with over 9M€ funding. He is recipient of several awards, including Ramon Areces and La Caixa Health, to develop graphene-based peripheral nervous system neural interfaces. J.A. Garrido is vice-director and head of the Strategy Development Office at the ICN2.

Wanlin Guo

Institute/Company：Nanjing University of Aeronautics and Astronautics
Affiliation：Professor
Email：wlguo@nuaa.edu.cn

Title of the presentation：
From interface interactions of 2D heterostructures to devices

Abstract：
“Interfaces are devices” is a widely recognized believing especially in the field of graphene-like two dimensional (2D) materials, where surfaces and interfaces dominate their device applications. However, to precisely determine the interface interactions of 2D heterostructures remains challenge and there is a lack of killer application. Here we report experimental and theoretical progresses in understanding the van der Waals (vdW) interactions at 2D heterointerfaces. Direct measurements using a graphite-wrapped or hexagonal boron nitride (BN) wrapped atomic force microscope tip show that the interface interactions between BN/graphite, BN/BN and MoS2/graphite are 0.953, 1.057 and 1.028 times of that between graphite/graphite, respectively. The results can be explained by the Lifshitz theory and is further checked by comparison with the strength of interaction at graphite/MoSe2, implying an important role of material dielectric function in determining the vdW interactions between the heterointerfaces. Guided by the finding, a technique to disassemble two-dimensional heterostructures is demonstrated, and accurate vdW-DFT theory is proposed and validated. Further probing the liquid-2DM interfaces and hydro-ion-electron systems at the aqueous solutions and solid interfaces brings us better understanding of the electrokinetic effect and opens new ways for harvesting electricity from water, leading to the emerging hydrovoltaics. The rapid advances along this line will also been reviewed and the challenges and chances will be outlined for discussion.

Biography：
Dr. Wanlin GUO, Academician of Chinese Academy of Sciences, Chair Professor in mechanics and nanoscience, founder and director of the Key Laboratory of Intelligent Nano Materials and Devices of Ministry of Education and the Institute of Nanoscience of Nanjing University of Aeronautics and Astronautics. His current research focuses on intelligent nano materials and devices, novel conception and technology for efficient energy conversion, molecular physical mechanics for neuronal signaling and molecular biomimics, as well as strength and safety of aircraft and engine. He has published more than 400 peer-reviewed journal papers on Nature series, Phys. Rev. Lett., J. Am. Chem. Soc., Adv. Mater., J. Mech. Phys. Solids, Nano Lett., etc. He received the National Science Foundation of China for Distinguished Young Scholars in 1996 and the position of Cheung Kong Scholars in 1999. He obtained the National Nature Science Prize of China in 2012 for his contribution to physics mechanics, and the ICCES Eric Reissner Award in 2019 for his sustained contributions to the integrity and durability of aerospace structures, and to nano-mechanics.

Jari Kinaret

Institute/Company： Graphene Flagship
Affiliation： Chalmers University of Technology
Email： jari.kinaret@chalmers.se

Title of the presentation：
Graphene Flagship

Abstract：
In this presentation I will briefly describe the current status and future plans of the Graphene Flagship. I will not address specific scientific or technological topics apart from a few highlights that are indicative of our current activities.

Biography：
Jari Kinaret is the initiator of the Graphene Flagship and serves since October 2013 as its Director. He received his M.Sc degrees in Theoretical Physics and in Electrical Engineering at the University of Oulu in Finland in 1986 and 1987, respectively. Kinaret graduated with a Ph.D. in Physics from the Massachusetts Institute of Technology in 1992, whereupon he spent two years in Copenhagen as a post-doctoral researcher and as an Assistant Professor. In 1995 he moved to Gothenburg where he works as Professor of Physics at the Chalmers University of Technology.

His research interests lie in theoretical studies of nanoscale carbon structures, with focus on nanoelectromechanical devices and graphene plasmonics. He is a member of the Royal Swedish Academy of Engineering Sciences and the board of directors of Tampere University (Finland).

Yunqi Liu

Institute/Company： Institute of Chemistry
Affiliation： Chinese Academy of Sciences
Email： liuyq@iccas.ac.cn

Title of the presentation：
Controllable growth and performance modulation of graphene

Abstract：
The controlled synthesis and property modulation of high quality graphene is one of important cutting-edge challenges in carbon chemistry and nanoscience, which hinders the further development of graphene-based fundamental research and industrial applications. In order to address these existing key issues, we break through the traditional way of thinking, and make a series of systematic innovative contributions in the controlled synthesis, property modulation and device applications of graphene.

In this presentation, by focusing on the challenging problem of controllable preparation and performance modulation of graphene, we carried out an in-depth and systematic research, opened up a liquid metal catalytic system for the synthesis of graphene by chemical vapor deposition (CVD), obtained n-type nitrogen-doped graphene materials for the first time, proposed new strategies for the direct growth of graphene on insulating substrates, and invented new technologies for the fabrication of graphene electronic devices.

Biography：
Yunqi Liu was graduated from Nanjing University in 1975, received a doctorate from Tokyo Institute of Technology, Japan in 1991. Presently, he is a Professor at the Institute of Chemistry, Chinese Academy of Sciences (CAS), an Academician of CAS, and a Member of The World Academy of Sciences (TWAS). His current research interests include design and synthesis of molecular materials, including -conjugated small molecules, polymers, and graphene, fabrication of related devices, including field-effect transistors and molecular electronics, and investigation of their electronic properties. He has published more than 600 papers in SCI journals (in which, over 160 of papers with IF>10), cited by other researchers for more than 30,000 times with an h-index >90. He was recognized as "Highly Cited Researchers" by Thomson Reuters in Materials Science from 2014 to 2018. In addition, he has obtained 70 of granted patents, published three books and 18 book chapters. He received the National Natural Science Award (2nd grade) in 2007 and 2016, and Beijing Science and Technology Award in 2017 (1st grade).

Guest introduction

Wencai Ren

Institute/Company：Institute of Metal Research, Chinese Academy of Sciences
Affiliation：Institute of Metal Research, Chinese Academy of Sciences **Email**
：wcren@imr.ac.cn

Title of the presentation：
Graphene films: Controlled synthesis and applications

Abstract：
Graphene films are essentially important to enable the excellent in-plane properties of graphene being utilized to the maximum extent at macroscopic scale, which can be directly grown by chemical vapour deposition (CVD) or assembled from graphene/graphene oxide (GO) nanosheets. In this talk, I will first introduce grain size and number of layers control, doping and clean transfer of CVD-grown graphene films and demonstrate their applications for flexible OLEDs. Then, I will introduce the synthesis of GO-based films with controlled alignment and compaction, and demonstrate their applica- tions for high-performance nanofiltration membranes, super-strong and highly conductive papers, electromagnetic interference shielding membranes, and flexible supercapacitors with record volumetric energy density.

Biography：
Dr. Wencai Ren is a professor in materials science at the Institute of Metal Research, Chinese Academy of Sciences. His research interests mainly focus on the synthesis of graphene and other two-dimensional materials and their applications in energy storage, composites and optoelectronics. Prof. Ren has published over 130 papers in Nature Mater., Nature Nanotechnol., Nature Commun., PNAS, Adv. Mater., JACS, etc. with a total citation over 22,000 times, and filed more than 80 patents (over 40 issued, 2 commercialized). He has received several awards including the Second Prize of National Natural Science Award, HO LEUNG HO LEE FOUNDATION Prize for Scientific and Technological Innovation, National Science Fund for Distinguished Young Scholars, and National Award for Youth in Science and Technology.

Hofmann Stephan

Institute/Company：University of Cambridge **Affiliation：**
Department of Engineering **Email：**sh315@cam.ac.uk

Title of the presentation：
Crystal Growth in the Flatland: Growth Mechanisms in 2D Materials and Pathways to Scalable, Controlled Device Integration

Abstract：
n order to serve the industrial demand for "electronic-grade" 2D materials, we focus on developing chemical vapour deposition (CVD) processes, and in this talk I will review our recent progress in scalable CVD [1] and device integration approaches of highly crystalline graphene, hexagonal boron nitride (h-BN) and transition metal dichalcogenide films (using MOCVD of WS2 as example). The systematic use of in-situ metrology, ranging from high-pressure XPS to environmental electron microscopy, allows us to reveal some of the key growth mechanisms for these 2D materials that dictate crystal phase, micro-structure, defects, and heterogeneous integration control at industrially relevant conditions.

h-BN not only is increasingly employed as support, encapsulant and barrier for 2D material technologies, but attracted recent interest as active material particularly for defect-induced sub-bandgap single photon emission at room temperature. We developed tailored CVD processes to achieve large monolayer h-BN domains with lateral sizes exceeding 1mm, coupled to application specific transfer methods [2]. We explore super-resolution imaging as means to h-BN layer characterization [3,4], and investigated approaches to control emitter stability/behavior and density/location for potential quantum applications. We also studied the role of less straightforward growth parame- ters such as dissolved species in the catalyst bulk, and here will highlight the significant effects of residual bulk oxygen in graphene and h-BN growth [5]. We show that such CVD graphene can sustain mobilities of 70000 cm2/Vs at RT even when initially wet-transferred [6]. We introduce the concept of solid catalysts for epitaxial growth of a semiconductor onto a 2D substrate, using the example of Ge growth on graphene or h-BN with an Au catalyst [7]. Free-standing graphene and h-BN membranes allow us to study such forms of epitaxy direct- ly by ETEM. With ETEM we recently also discovered how a 2D layer forms on a liquid alloy droplet [8], and we discuss strategies tocontrol the presence of such 2D surface phases, using it as a tool in designing strategies for nanostructure growth.

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Biography：
Stephan Hofmann is Professor of Nanotechnology at the Department of Engineering at Cambridge, where he leads research on the application driven exploration of new device materials, bridging from fundamental discovery and charac- terisation of properties to functional device integration and manufacturing pathways. He graduated in Physics at the Technische Universität München and obtained his Ph.D. at the University of Cambridge. Prior to his faculty position, he held a Dorothy Hodgkin Fellowship by the Royal Society (U.K.) and a Research Fellowship at Peterhouse, Cambridge, where he is currently a Fellow.

Guest introduction

Ping-Heng Tan

Institute/Company : Institute of Semiconductors **Affiliation :** Chinese Academy of Sciences **Email :** phtan@semi.ac.cn

Title of the presentation :
Cross-dimensional Electron-phonon coupling in van der Waals heterostructures

Abstract :
The electron-phonon coupling (EPC) in a material is at the frontier of the fundamental research, underlying many quantum behaviors. van der Waals heterostructures (vdWHs) provide an ideal platform to reveal the intrinsic interaction between their electrons and phonons. In particular, the flexible van der Waals stacking of different atomic crystals leads to multiple opportunities to engineer the interlayer phonon modes for EPC. In this talk, we will show that many layer-breathing modes were observed in WS2/hBN vdWHs, whose positions are dependent on number of the layers of two constituents in vdWHs. We will discuss the strong coupling between the layer-breathing phonons and the electrons in WS2/hBN vdWHs. The strength of such EPC can be well reproduced by a microscopic picture mediated by the interfacial coupling and the interlayer bond polarizability model in vdWHs. This EPC study paves the way to manipulate the interaction between electrons and phonons in various vdWHs by interfacial engineering for possible interesting physical phenomena.

Biography :
In 2001, he received Ph. D degree in Institute of Semiconductors, Chinese Academy of Sciences (IS-CAS), China. Then, he moved to Walter Schottky Institut, Technische Universitaet Muenchen as a postdoctoral researcher. He joined IS-CAS as an associated professor in 2003 and became a professor in 2009. He had published over 190 peer-reviewed papers in scientific journals. He was supported by NSFC for Distinguished Young Scholars in 2012 and was awarded Huang Kun prize in Physics in 2015. Now, he is the International Steering Committee member of ICORS, chair of the Chinese Light Scattering Committee, the Editorial Board members of "Journal of Raman Spectroscopy", "Semiconductor Science and Technology", and "npj 2D Materials and Applications".

Haomin Wang

Institute/Company :
[1] State Key Laboratory of Functional Materials for Informatics, Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences
[2] School of Optical and Electronic Information, Huazhong University of Science and Technology
Email : hmwang@mail.sim.ac.cn

Title of the presentation :
Isolating hydrogen in hexagonal boron nitride bubbles by a plasma treatment

Abstract :
Atomically thin hexagonal boron nitride (h-BN) is often regarded as an elastic film that is impermeable to gases. The high stabilities in thermal and chemical properties allow h-BN to serve as a gas barrier under extreme conditions. Here, we demonstrate the isolation of hydrogen in bubbles of h-BN via plasma treatment. Detailed characterizations reveal that the substrates do not show chemical change after treatment. The bubbles are found to withstand thermal treatment in air, even at 800°C. Scanning transmission electron microscopy investigation shows that the h-BN multilayer has a unique aligned porous stacking nature, which is essential for the character of being transparent to atomic hydrogen but impermeable to hydrogen molecules. In addition, we successfully demonstrated the extraction of hydrogen gases from gaseous compounds or mixtures containing hydrogen element. The successful production of hydrogen bubbles on h-BN flakes has potential for further application in nano/micro-electromechanical modulator of single photon emitter and the color centre in diamond.

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[7] Periwal, Ross et al, submitted (2019).
[8] Panciera et al., Adv. Mater. 31, 1806544 (2019).

Biography :

Towards Chirality Control of Graphene Nanoribbons Embedded in Hexagonal Boron Nitride
Ideal graphene nanoribbons (GNRs) have been shown to exhibit extreme chirality dependence as metals or semiconductors. Therefore, the capability to precisely produce GNRs with defined chirality at the atomic level is required in order to engineer their band gap and electrical properties. It is obvious that earlier approaches have fundamental limitations for further electronic investigation. Electronics always require scalable transfer-free approaches for growing GNRs and conducting band gap engineering. Controlled fabrication of oriented GNRs embedded on hexagonal boron nitride (h-BN) has the capability to overcome the above difficulties. With proper control, the band gap and magnetic properties can be precisely engineered. Most desired features for GNRs can be automatically attained using this approach.
Here we developed a two-step growth method and successfully achieved sub-5 nm zigzag and armchair GNRs embedded in h-BN, respectively. Further transport measurements reveal that the sub-7 nm zigzag GNRs exhibit openings of the bandgap inversely proportional to their width, while narrow armchair GNRs exhibit some fluctuation in the bandgap-width relationship. Transistors made of these GNRs with large bandgaps (>0.4 eV) exhibit excellent electronic performance even at room temperature (e.g. conductance on-off ratio more than 105 and carrier mobility more than 1,500 cm2 V−1 s−1). An obvious conductance peak is observed in the transfer curve of 8-10 nm-wide zigzag GNRs while it is absent in most of armchair GNRs of similar width. Magneto-transport experiments show that zigzag GNRs exhibit relatively small magneto-conductance (MC) while armchair GNRs have much higher MC than zigzag GNRs. This integrated lateral growth of edge-specific GNRs in h-BN brings more robust and orientation-controlled edges than previously demonstrated, and will enable exciting future investigations into the physics and applications of edge-specific GNRs.

Yeliang Wang

Institute/Company：Beijing Institute of Technology
Email：yeliang.wang@bit.edu.cn

Title of the presentation：
Controllable Growth and Properties of VSe2 monolayer and 1D-patterned Supersturtures

Abstract：
The novel properties of graphene honeycomb structure have spurred tremendous interest in investigating other two-dimensional (2D) layered structures beyond graphene for nanodevices. In this talk, I will mentioned the fabrication and properties of several 2D materials such as graphene, such as, silicene[1], germanene[2] hafnene[3] and topological antimonene with flat or undulated configuration [4], wherein silicon (germanium, hafnium or antimony) atoms are substituted for carbon atoms in graphene. Besides mono-elemental 2D atomic crystals, bi-elemental 2D materials, such as magnetic VSe_2 monolayer and 1D-patterned VSe_2[5], semiconducting $PtSe_2$ monolayer and its intrinsically patterns [6,9], and superconductor transition-metal-trichalcogenide ($HfTe_3$)[7], grown by direct selenization/tellurization of the Pt/Hf substrate, as well as their application exploring in nanoelectronics and valleytronics will also be introduced. In addition, the stacking heterolayers based on several these kinds of 2D materials, for instance, a superconductor-topological insulator layered heterostructure (with a $HfTe_3/HfTe_5$ layered configuration) for Majorana bound states will be also presented [8]. The precise structural configurations at atomic-resolution of these materials will also be introduced, based on the measurements by several advanced techniques like LEED, STM/STS and STEM.
* Achievements of Prof. Hongjun GAO's group in the Institute of Physics, Chinese Academy of Sciences, while the presenter is a group member there from 2008-2018.

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Kehui Wu

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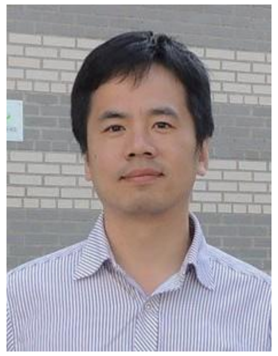

Title of the presentation：
Borophene

Abstract：
Unlike the honeycomb structure of graphene, 2D boron sheets, namely borophene, possesses enormous polymorphs arising from periodic hole patterns in a triangular lattice. In this talk, I will discuss our recent experimental progress in the epitaxial growth 2D boron sheets. We found that the structure of 2D boron sheets can be tuned by the interaction and charge transfer between the film and the substrate. And even a honeycomb 2D boron sheet can be achieved by using Al (111) as the substrate. I will also present our recent study on the electronic and vibrational properties of 2D boron sheets by ARPES and tip-enhanced Raman spectroscopy.

Biography：
Prof. Kehui Wu, Institute of Physics, Chinese Academy of Science, China
Kehui Wu is a research group leader in the State Key Laboratory for Surface Physics, Institute of Physics, Chinese Academy of Science (CAS), and also a professor of University of CAS. He received his Ph.D. degree in condense matter physics from the Institute of Physics, CAS in 2000. He was then a postdoctoral fellow at the Institute for Materials Research in the Tohoku Univ., Japan from 2000 to 2004. In 2005 he received support from joined the Institute of Physics, CAS as a professor. His research interests include the growth of low-dimensional materials (particularly 2D materials) by molecular beam epitaxy (MBE), and atomic level studies by scanning tunneling microscopy/spectroscopy (STM/STS) based techniques. His recent works include experimental discoveries of silicene and 2D boron (borophene).

Yanfeng Zhang

Institute/Company： Peking University

Affiliation： Department of Materials Science and Engineering, College of Engineering

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Title of the presentation：
Wafer Scale Syntheses and application explorations of Transitional Metal Dichalcogenides

Abstract：
As structural analogues of graphene but with a sizeable band gap, monolayers of group-VIB transition metal dichalcogenides (MX_2, M = Mo, W; X = S, Se, Te, etc.) have emerged as prototypes for engineering a wide range optoelectronic, photocatalytic and electrocatalytic related applications. To achieve this, controlled growth of large-area uniform monolayer MX_2 is a crucial issue. [1] Herein, we report the direct synthesis of 6-inch uniform monolayer MoS_2 on the unique soda-lime glass through a designed "face-to-face" metal-precursor supply route. This system is featured with large domain size ~400 μm, quite short growth time ~8 min, and is compatible with a water-as- sisted clean transfer strategy. This work provides novel insights into the batch production and green transfer of highly uniform monolayer MX_2 films. [2] We have also realized the fast growth of 6-inch scale, thickness tunable MoS_2 flakes on the soda-lime glass (from 1L to 20L). Naturally evolved 1L and multilayer (ML) MoS_2 lateral junctions were also used to fabricate high performance optoelectronic devices, with relative high rectification ratio (~103) and extra high photoresponsitivity (~104A/W).

Metallic transition metal dichalcogenides (MTMDCs) have manifested many intriguing properties in their bulk states, such as magnetism, charge density wave, and superconductivity. To propel the related applications, our group have also realized the direct syntheses of high-quality VX_2 and TaX_2 related MTMDCs materials on both conducting Au foils and insulating substrates.[3, 4]. Particularly, we have obtained thickness-tunable 2H-TaS_2 flakes and centimeter-size ultrathin films on an electrode material of Au foils. Extra high hydrogen evolution reaction (HER) efficiency was demonstrated on the CVD-grown 2H-TaS_2/Au foils.[5] The first synthesis of vertically oriented 1T-TaS_2 nanosheets was also reported on nanoporous gold (NPG) substrates. The influence of phase states of 1T- and 2H- TaS_2 on the catalytic activity was thus explored according to density functional theory calculations and comparative HER measurements. All these work should provide brand new insights into the direct syntheses and property investigations of nano-thick metallic 2D TMDCs crystals.

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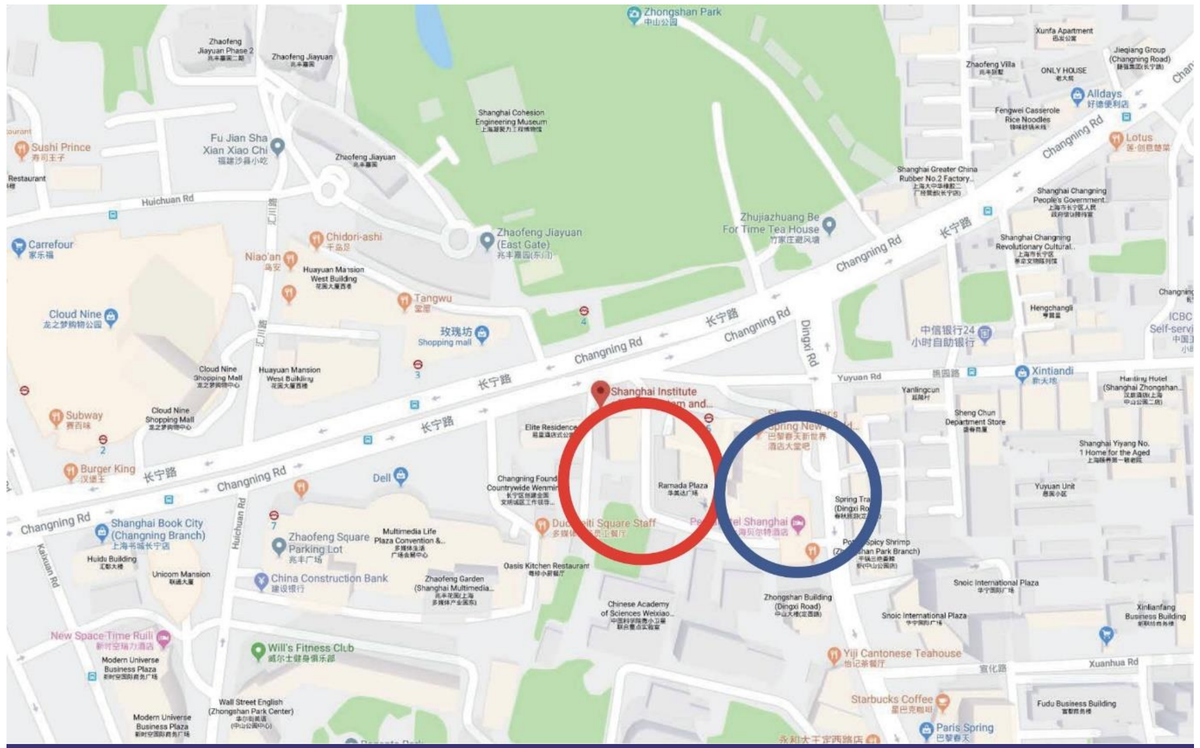
Biography：
Yanfeng Zhang received her PhD from the Institute of Physics in the Chinese Academy of Sciences in 2005. Later on, she worked as a JSPS fellow from 2006 to 2009 in Tohoku University, Japan. In 2010, she joined the Department of Materials Science and Engineering in the College of Engineering of Peking University, and Center for Nanochemistry of Peking University, and served as a professor.
Her research interests relate to the controlled growth, accurate characterization and novel property exploration of two-di-mensional layered materials such as graphene, h-BN-graphene heterostructures, and transition metal dichalcogenides (TMDCs) and their heterostructures. Prof. Zhang has published over 140 papers in Science, Nat. Commun., Adv. Mater., etc. in her research career. All the papers are non-self-cited by over 5000 times. In 2012, she won the support of "Nation-al Natural Science Foundation for Excellent Young Scholar" from the National Natural Science Foundation of China (NSFC). She was also enrolled in the "Youth Project of the Yangtze River Scholar" in 2015.



Conference address:
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The red circle indicates the workshop venue and blue circle indicates the hotel.

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Hotel booking: We have book the hotel for invited speakers.

Event Details - EU-China 2019

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