Master Lectures

Date: 2023/09/14
Venue: B106 Auditorium, 1F, Interdisciplinary Research Building for Science and Technology, Academia Sinica

9/14，14:00-14:40
Prof. Nai-Chang Yeh
Thomas W. Hogan Professor of Physics
California Institute of Technology
Title: A perspective of recent scientific and technological advances in the research of two-dimensional van der Waals materials

9/14，15:00-15:40
Academician Tai Chang Chiang
Department of Physics, University of Illinois at Urbana-Champaign
Title: Coherent Electronic Band Structure of TiTe2/TiSe2 Moiré Bilayer

9/14，16:00-16:40
Prof. Hiroaki Misawa
RIES, Hokkaido University, Center for Emergent Functional Matter Science, National Yang Ming Chiao Tung University
Title: Mechanism of hot electron transfer at Au nanostructure/TiO2 interface under modal strong coupling conditions

Organized by Research Center for Applied Sciences
Contact: Ms. Chun-Fang Chang, Email: chunfang@sinica.edu.tw, TEL:2787-3102

Master Lectures

Date: 2023/09/15
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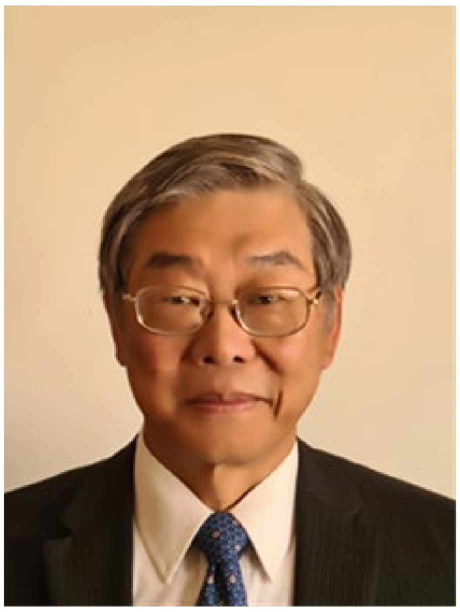
9/15，09:00-09:40
Prof. Jackie Y. Ying
NanoBio Lab, A*STAR, Singapore
www.jyyinglab.net
Title: Design and Synthesis of Nanomaterials for Biomedical and Energy Applications



9/15，09:40-10:20
Academician Yu-Chong Tai
Anna L. Rosen Prof. of EE and MedE
Division of Engineering and Applied Science
California Institute of Technology (Caltech)
Title: MEMS Biomedical Devices

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Master Lecture

9/14，14:00-14:40

Prof. Nai-Chang Yeh
Thomas W. Hogan Professor of Physics
California Institute of Technology

Title: A perspective of recent scientific and technological advances in the research of two-dimensional van der Waals materials

Two-dimensional (2D) van der Waals (vdW) materials, such as graphene, hexagonal boron nitride (h-BN) and transition metal dichalcogenides (TMDs), are quantum materials exhibiting a rich variety of properties that are not only exciting for scientific research but also promising for a wide range of technological applications. In this talk I will first summarize the recent developments in my group on graphene-based technologies, ranging from flexible electronics, interconnects, anticorrosion for biomedical and photovoltaic applications, superlubricity, and photonics. These studies are all based on graphene synthesized by scalable, reproducible, and industrially compatible method of plasma enhanced chemical vapor deposition (PECVD). Next, I will describe three topics of our scientific studies based on vdW materials, which include 1) straintronic devices based on nanoscale strain engineering of monolayer graphene that exhibit strain-controlled emerging quantum phenomena; 2) room-temperature topological photonics based on monolayer TMDs, plasmonic metasurfaces, and topological light (i.e., photons with nontrivial spin or orbital angular momenta); and 3) giant ferroelectric and optoelectronic responses from field effect transistors made of monolayer TMDs. Finally, I will discuss the outlook of developing scalable and CMOS compatible synthesis of monolayer and few-layer 2D-TMDs, which will be critically important for realizing the full technological potential of TMDs

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Academician Tai Chang Chiang
Department of Physics, University of Illinois at Urbana-Champaign

Title: Coherent Electronic Band Structure of TiTe2/TiSe2 Moiré Bilayer

Moiré structures form when two 2-dimensional lattices with slightly different geometries are overlaid. A number of such systems (twisted bilayer graphene, for example) have shown unusual properties, thus suggesting a powerful approach for engineering novel and useful systems. This talk will focus on a van der Waals-bonded moiré bilayer formed by sequential growth of TiSe2 and TiTe2 monolayers, which exhibits emergent electronic structure as evidenced by angle-resolved photoemission band mapping. The two monolayers adopt the same lattice orientation but incommensurate lattice constants. Despite the lack of translational symmetry, sharp dispersive bands are observed and appear distinct from those for the component monolayers alone. Theoretical calculations show the formation of composite bands by coherent electronic coupling despite the weak interlayer bonding, which leads to band renormalization and energy shifts. The results illustrate how emergent electronic effects can arise from such layer stacking.

In collaboration with Meng-Kai Lin, Tao He, Joseph A. Hlevyack, Peng Chen, Sung-Kwan Mo, and Mei-Yin Chou.

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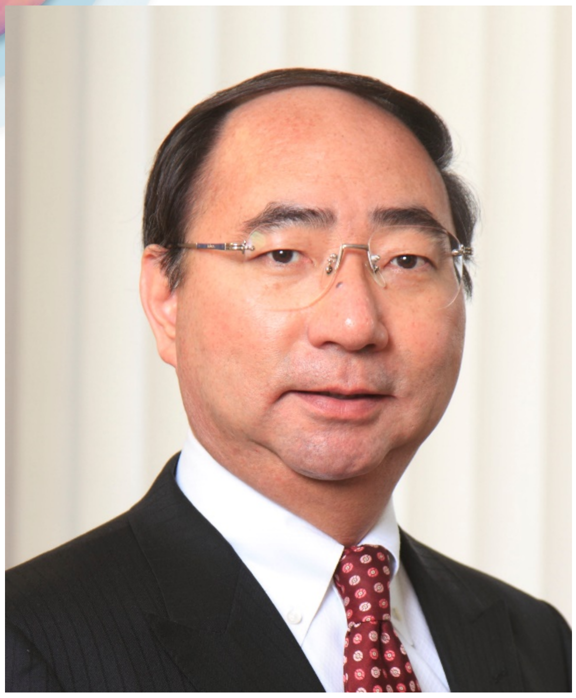

9/14，16:00-16:40

Prof. Hiroaki Misawa
RIES, Hokkaido University, Center for Emergent Functional Matter Science, National Yang Ming Chiao Tung University

Title: Mechanism of hot electron transfer at Au nanostructure/TiO2 interface under modal strong coupling conditions

It is possible to convert visible light energy into electrical energy using water as an electron source through a plasmon electrode with gold nanoparticles (Au-NPs) loaded onto a titanium dioxide (TiO2) semiconductor electrode. However, effectively absorbing visible light with a single layer of AuNPs on the electrode is challenging. We fabricated a TiO2 electrode with nanocavity functionality and matched its resonance mode with that of plasmon resonance by controlling the thickness of the TiO2 film. This resulted in a strong coupling between the nanocavity and plasmon, leading to the emergence of two new hybrid modes with high absorption intensity in the absorption spectra. When this electrode with strong coupling was used as a working electrode, we observed an enhancement in the quantum yield of photocurrent generation compared to the conventional plasmonic working electrode. In my talk, I will present our recent studies on the mechanism behind this enhanced quantum yield of photocurrent generation.

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Prof. Jackie Y. Ying
NanoBio Lab, A*STAR, Singapore
www.jyyinglab.net

Title: Design and Synthesis of Nanomaterials for Biomedical and Energy Applications

Nanostructured materials can be designed with sophisticated features to fulfill the complex requirements of advanced material applications. Our laboratory has developed organic and inorganic nanoparticles and nanocomposites for advanced drug delivery, antimicrobial, stem cell culture, and tissue engineering applications. In addition, we have nanofabricated microfluidic systems for drug screening, in vitro toxicology, and diagnostic applications. The nanosystems allow for the rapid and automated processing of drug candidates and clinical samples in tiny volumes, greatly facilitating drug testing, genotyping assays, infectious disease detection, point-of-care monitoring, as well as cancer diagnosis and prognosis.

We have also synthesized metallic, metal oxide and semiconducting nanoclusters, nanocrystals and nanosheets of controlled dimensions and morphology. The nano-sized building blocks are used to create multifunctional systems with excellent dispersion and unique properties. Nanoporous materials of a variety of metal oxide and organic backbone have also been created with high surface areas and well-defined porosities. These nanostructured materials are successfully tailored towards energy and sustainability applications.

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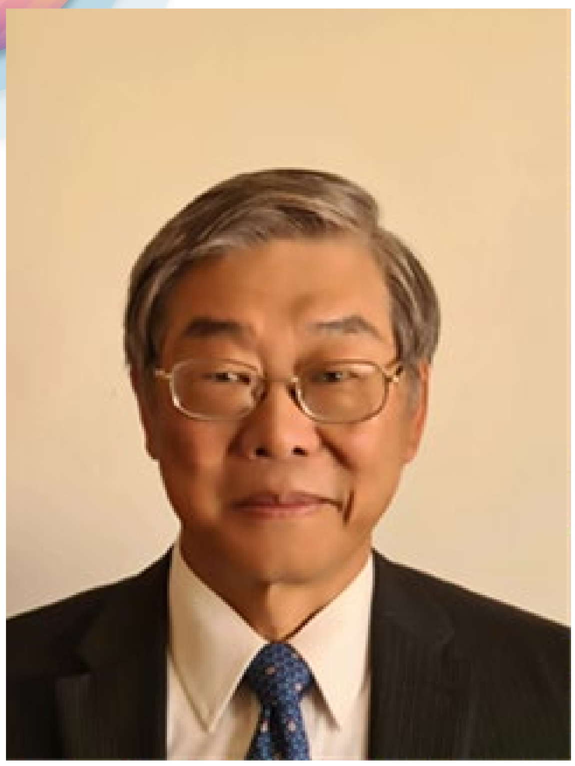

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Academician Yu-Chong Tai
Anna L. Rosen Prof. of EE and MedE
Division of Engineering and Applied Science
California Institute of Technology (Caltech)

Title: MEMS Biomedical Devices

History proves that biomedical devices can re-interface with body tissues and/or to replace defective functions and are the dominant methods to treat many diseases such as in brain, eye, and heart. Interestingly, however, the field of Micro-Electro-Mechanical Systems (MEMS) has advanced tremendously for the last 30 years but, most noticeably, MEMS are only known to produce a new generation of miniature or chip-sized microsensors such as pressure sensors, accelerometers, gyros, microphones for cell phones and smart instrumentation. As a matter of fact, I think the time has come for MEMS to play a big role in biomedical devices and the results will be another new generation of smaller, better, and cheaper "MEMS biomedical devices," in which both academia and industry should invest. Of course, there are challenging issues to be solved such as long-term reliability, mechanical flexibility, low power consumption, surgical placement/fixation, etc. but these are not unsolvable problems. This talk will then share my experience in developing MEMS biomedical devices covering immediate issues of materials, device design, and technologies. In chronicle order, three examples will be given, and they are retinal implants to treat blindness, point-of-care (POC) complete blood count (CBC) using one drop of blood, and O2 transporter/distributor for islets implant to treat type-I diabetes.

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