

# MSE-Colloquium@NTU

20 October 2014, 4.00pm (refreshments will be served at 3.30pm)

Lecture Theatre 4, Nanyang Technological University



## 2D Materials and Beyond: Progress and Prospects

**Professor Andrew Wee**

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### About the Talk

Graphene has captured the attention of the materials community in the past decade. Graphene, an atomically thin layer of carbon, is a semi-metal and hence a good electrical conductor that can be used in applications such as transparent conducting electrodes. However, there are numerous other 2D materials with properties that are complementary to those of graphene. Transition metal dichalcogenides (TMDs), such as  $\text{MoS}_2$  and  $\text{WSe}_2$ , are semiconductors with tuneable bandgap depending on the number of atomic layers, and have potential electronic and optoelectronic applications. Phosphorene is a layer of phosphorus atoms in the shape of an accordion with an electronic gap of a few electron volts that is ideal for digital applications such as atomically thin transistors.

In this talk, I will give an overview of progress in the field, as well as specific examples from our NUS Surface Science Laboratory. We have demonstrated both bottom-up and top-down methods for fabricating 1D graphene nanoribbons with tunable electronic bandgaps, thereby enabling graphene electronic and optoelectronic applications. We have investigated surface-assisted bottom-up fabrication of atomically precise armchair graphene nanoribbons (AGNRs) with predefined widths, namely 7-, 14- and 21-AGNRs, on Ag(111) as well as their spatially resolved width-dependent electronic structures. We also demonstrate the top-down fabrication of an intramolecular junction by the controllable unzipping of single-walled carbon nanotubes, combining a graphene nanoribbon and single-walled carbon nanotube in a 1D nanostructure. This junction shows strong gate-dependent rectifying behavior, and we demonstrate the use of the junction in prototype directionally dependent field-effect transistors, logic gates and high performance photodetectors.

In the field of 2D TMDs, we use high resolution STM/STS to study the atomic structure and intrinsic electronic properties of  $\text{MoS}_2$  layers (mono-, bi-, tri-) directly deposited on HOPG substrates by CVD. We also investigate highly crystalline and large-area  $\text{WSe}_2$  monolayers on sapphire grown by CVD. The monolayer films display strong photoluminescence, opening up potential applications in optoelectronics. Preliminary results on phosphorene will also be presented.

### About the Speaker

Professor Andrew Wee is a Professor of Physics at the National University of Singapore (NUS), and also Director of the Surface Science Laboratory. He is also NUS' Vice President (University and Global Relations), and was previously Dean of Science (2007-2014). He is President of the Singapore National Academy of Science (SNAS). He was awarded the President's medal in 2008 by the Institute of Physics Singapore (IPS), and is a Fellow of the Institute of Physics (IoP) UK, IPS and SNAS, as well as an academican of the Asia-Pacific Academy of Materials.