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### Configuring 2D materials by stacking order for energy harvesting and homo-junctions

It is well established that the optical and electronic structures of two dimensional transition metal dichalcogenide (2D TMD) materials and perovskites often show very strong layer-dependent properties. It is less well-known that the properties can also be tuned by stacking order, which allows us to build electro and optical devices with the same material and the same thickness. Detailed understanding of the inter-layer interaction will help greatly in tailoring the properties of 2D TMD materials for applications, e.g. in p-n junction, transistors, solar cells and LEDs. Raman/photoluminescence (PL) spectroscopy and imaging have been extensively used in the study of nano-materials and nano-devices. They provide critical information for the characterization of the materials such as electronic structure, optical property, phonon structure, defects, doping and stacking sequence. In this presentation, we use Raman and PL techniques and electric measurements, as well as simulation to study 2- and 3-layer 2D TMD samples. The Raman and PL spectra also show clear correlation with layer-thickness and stacking sequence. Electrical experiments and *ab initio* calculations reveal that difference in the electronic structures mainly arises from competition between spin-orbit coupling and interlayer coupling in different structural configurations. 2D material homo-junctions using 2H and 3R stacking show clear p-n junction behavior which opens up unique potential applications for nano-electronics and solar cells.

### Biography

Ze Xiang Shen is a Professor in the School of Physical and Mathematical Sciences at Nanyang Technological University (NTU); Co-director at the Centre for Disruptive Photonics Technologies. His main research areas include graphene, 2D materials and perovskites. He also works on graphene based composites for energy harvesting (Li Ion batteries and supercapacitors) and nano electronics. He has won the NTU Nanyang Award for Research and Innovation and Gold Medal for Research Excellence by Institute of Physics Singapore. He authored over 500 peer reviewed journal papers, six book chapters, edited five books and over 300 conference papers.

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