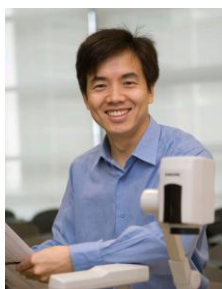




## OSE Visitor Research Seminars



# Semiconducting Nanomaterials and Heterostructures: Rational Synthesis and Optical Properties



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Nanyang Technological University, Singapore

**Friday, December 2, 9:30am**

*Physics and Astronomy, Room 190*

Rational synthesis and fabrication of high quality, large scale semiconducting nanomaterials and heterostructures are of fundamental importance towards functional nanoscale optoelectronic and nanophotonic devices. In this presentation, we will first discuss our recent progress in large scale vertically aligned synthesis of semiconducting nanostructures with catalyst-free growth via a novel van der Waals epitaxy mechanism. A selection of binary semiconductor nanowires were synthesized on (001) muscovite mica substrate using a vapor transport process without any introduction of foreign catalyst. Similar strategy can also result in polytypic tripod nano- and microcrystals of II-VI semiconductor on muscovite mica with pronounced preferential orientation of the tripods' legs with respect to the substrate, which is a strong indication of epitaxial relation.

The second part of the talk will cover the exciton dynamics in high quality CdS nanobelt probed by low-temperature steady state and time-resolved photoluminescence (PL) spectroscopy. The strong emission originates from the radiative recombination of excitons bound to neutral donors (I<sub>2</sub>) and the spatially-localized donor-acceptor pair (DAP) emission, in which the assignment is supported by first principle calculations. Our results verify that the shallow donors in CdS are contributed by sulfur vacancies while the acceptors are contributed by cadmium vacancies. At high excitation intensities, the DAP emission saturates and the PL is dominated by I<sub>2</sub> emission. Beyond a threshold fluence of  $\sim 4$  J/cm<sup>2</sup>, amplified spontaneous emission (ASE) of I<sub>2</sub> occurs. The much longer lifetime of DAP compared to that of I<sub>2</sub> emission indicates spin triplet state related emission phenomenon, which is supported by our calculation that cadmium vacancies are spin polarized and thereby the spin-orbit coupling is significantly enhanced.

#### References:

- Utama et al., *Nano Lett.*, 11, 3051-3057, 2011.
- Xu et al., *ACS Nano*, 5, 3660-3669, 2011.
- Chen et al., *Adv. Mater.*, 23, 1404-1408, 2011.

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