

# *XANES and XEOL Studies of Nano-heterostructures*

*- Zhiqiang Wang*

- XANES and XEOL of 1D nano-heterostructures
  - ZnO/CdS nanowire arrays
  - ZnS/ZnO nano-heterostructures with different morphologies
- STXM of 1D nano-heterostructures
  - Branched Sn/CNT core/shell nanostructures

# Objective

- Optical properties of semiconducting nanomaterials (origin of luminescence in multi-component system)
- Chemical imaging of nano-heterostructures

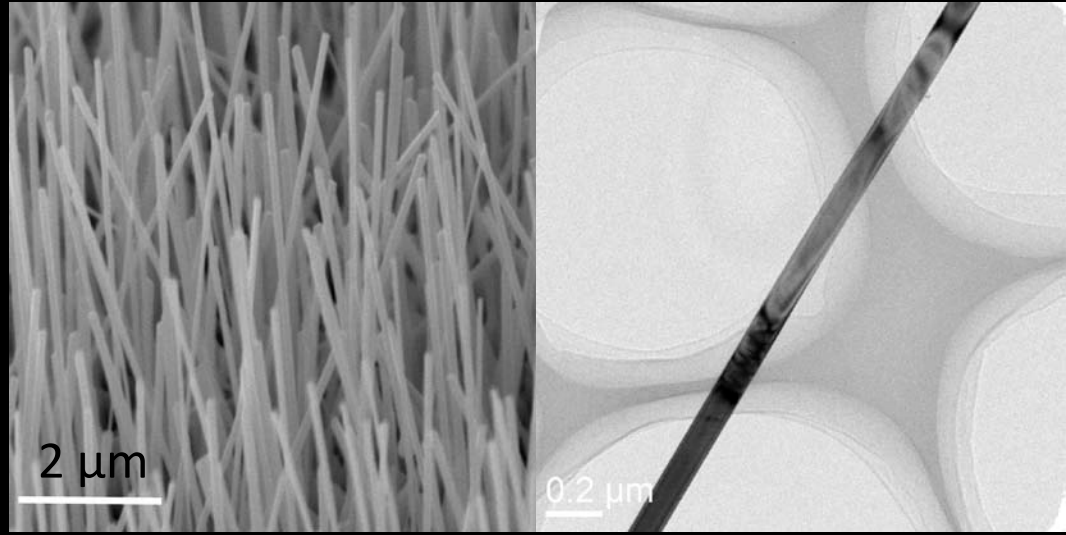
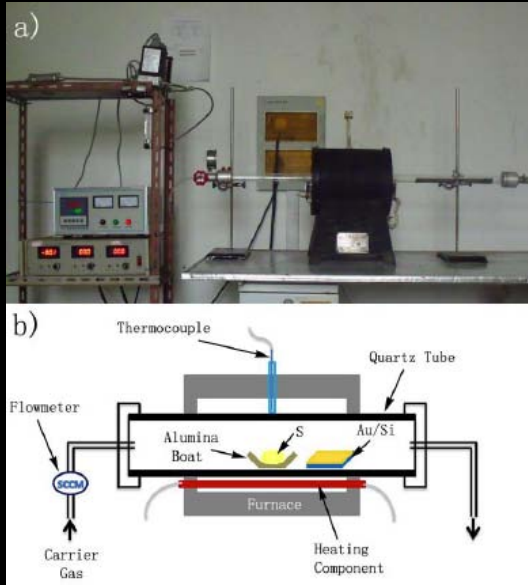
# Methodology

- Synthesis
  - Chemical Vapor Deposition (CVD)
- Characterization
  - XRD, SEM and TEM
  - XEOL in combination with XANES
  - Scanning Transmission X-ray Microscope (STXM)

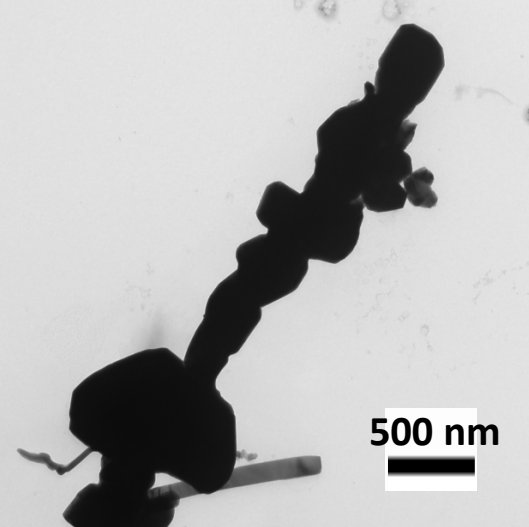
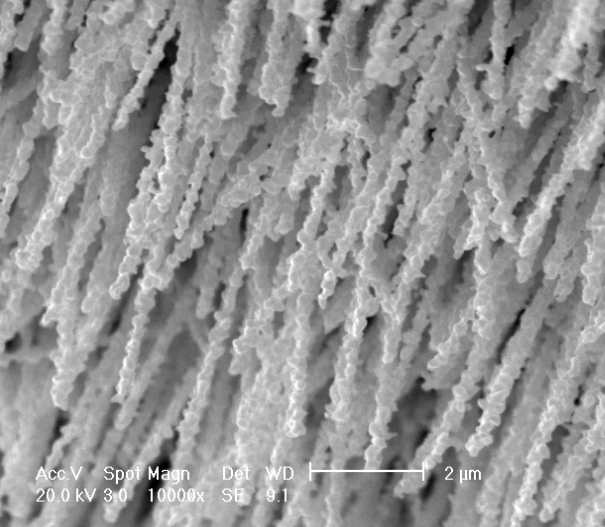
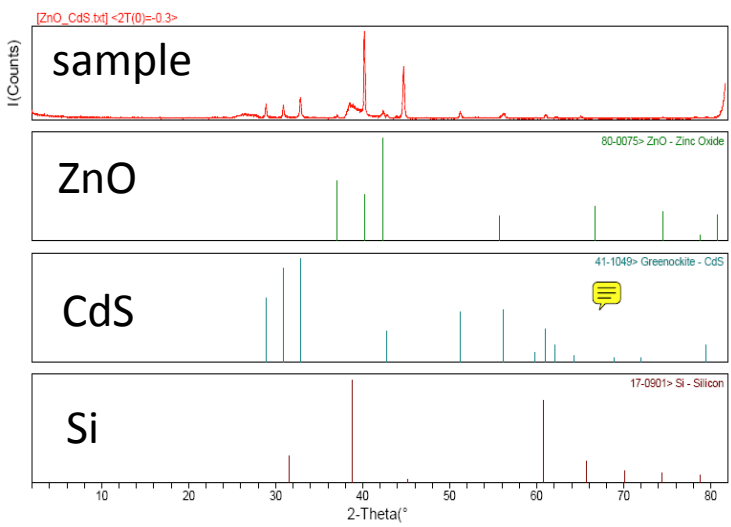
# I. Origin of the Luminescence from ZnO/CdS Nanowire Arrays via XEOL

CVD

ZnO NW arrays

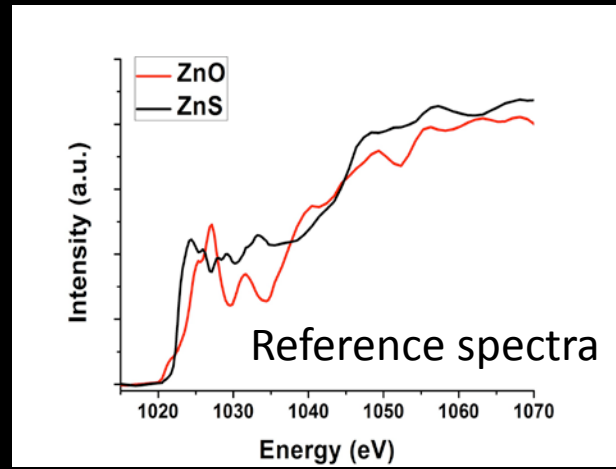
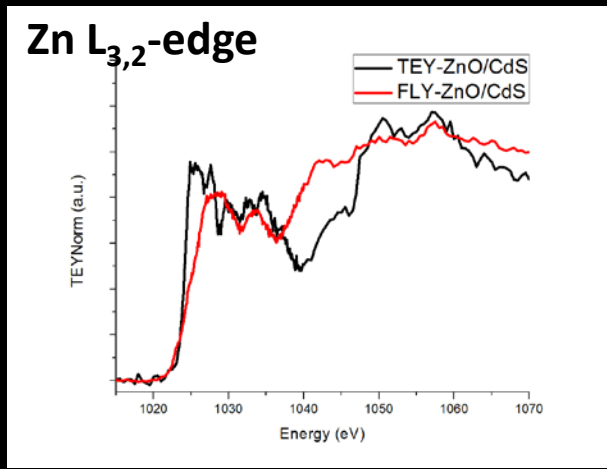
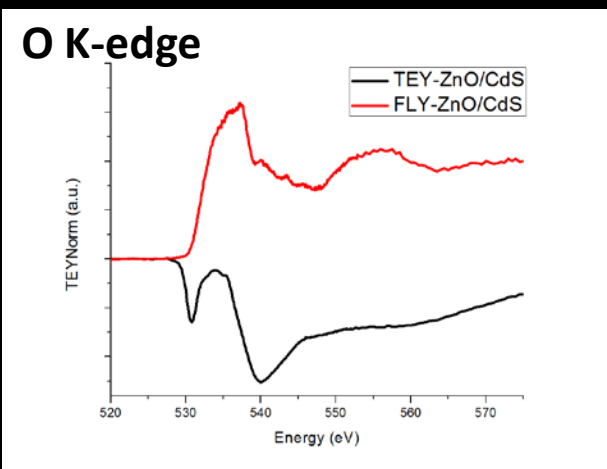
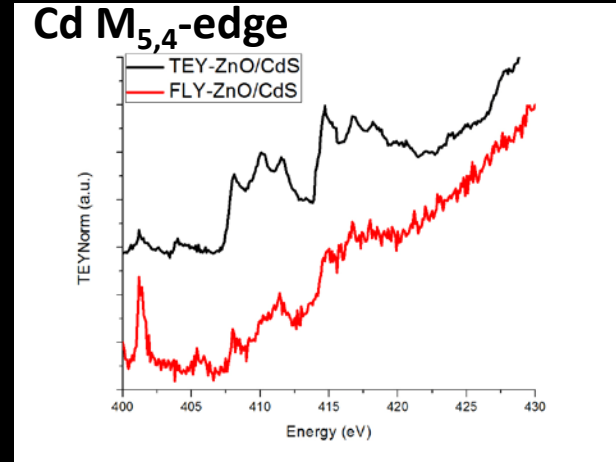
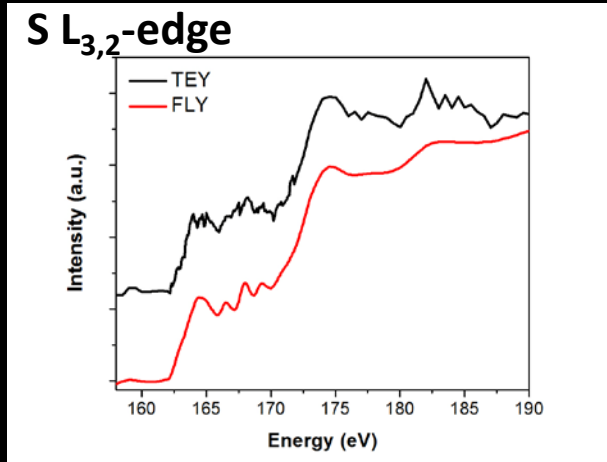
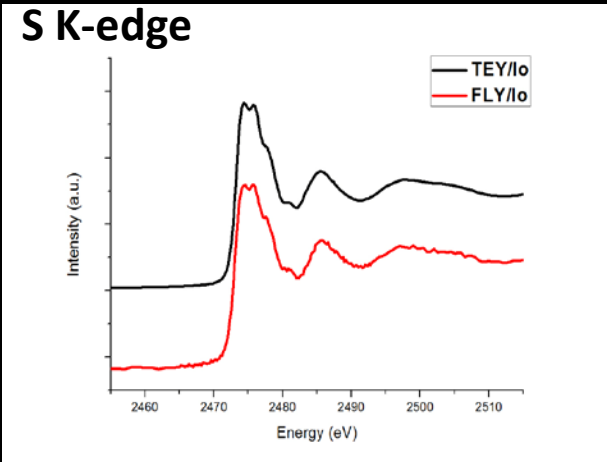


ZnO/CdS NW arrays



# I. Origin of the Luminescence from ZnO/CdS Nanowire Arrays via XEOL

## XANES spectra

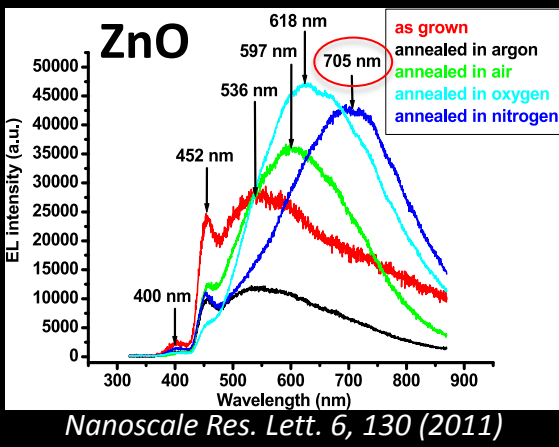
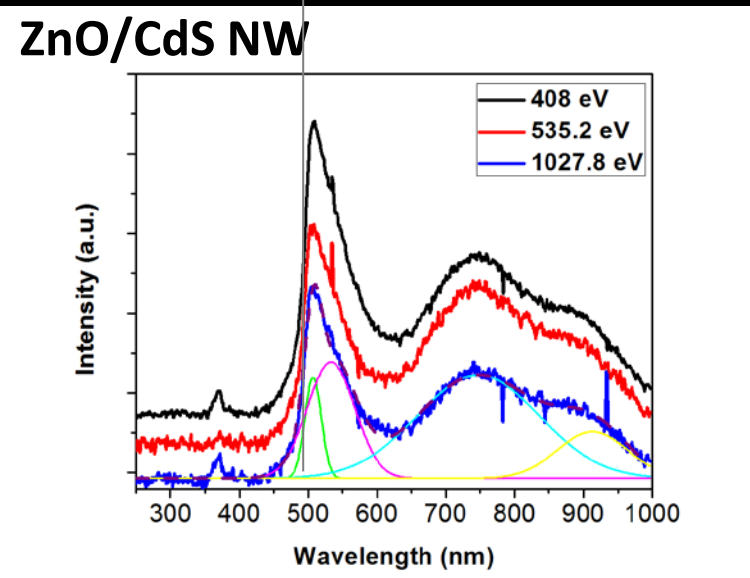
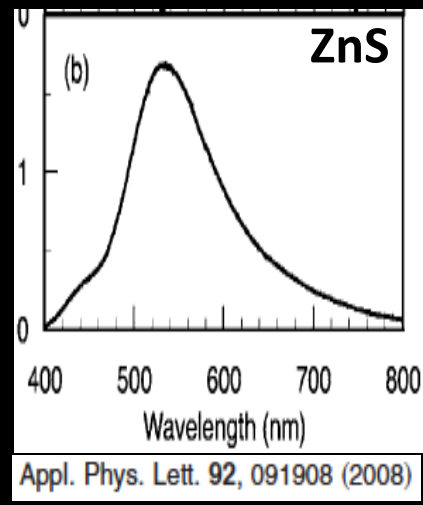
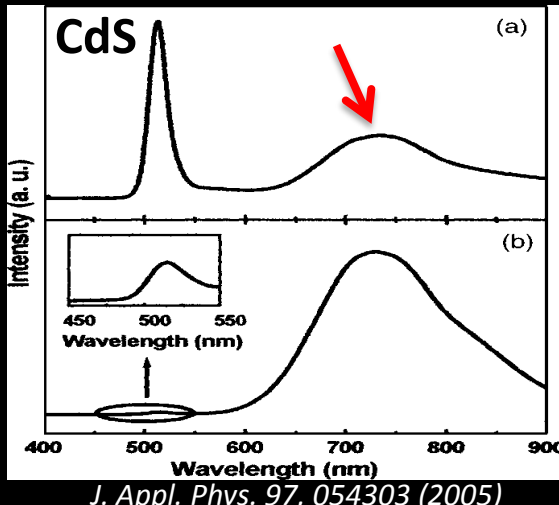
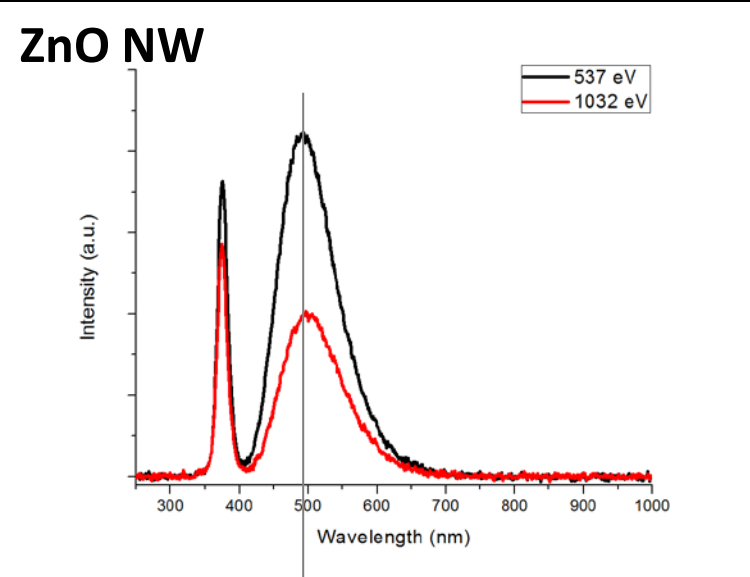


✧ Showing features from CdS and ZnO

✧ Core: ZnO

✧ Interface: ZnS

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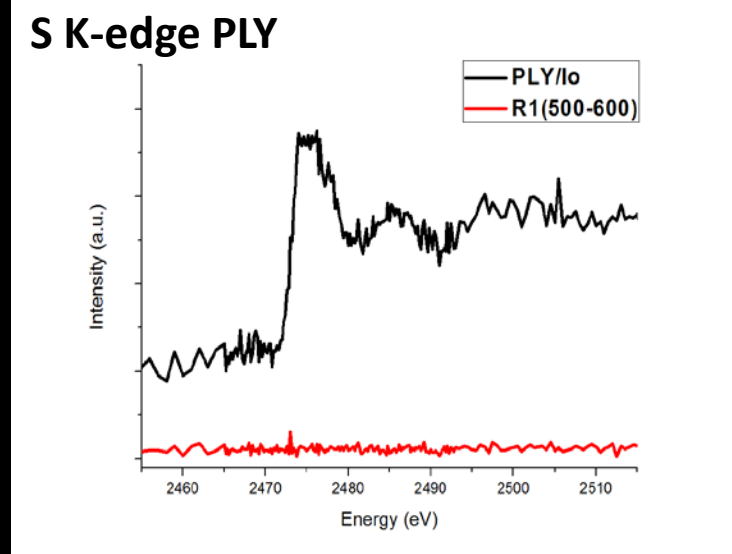
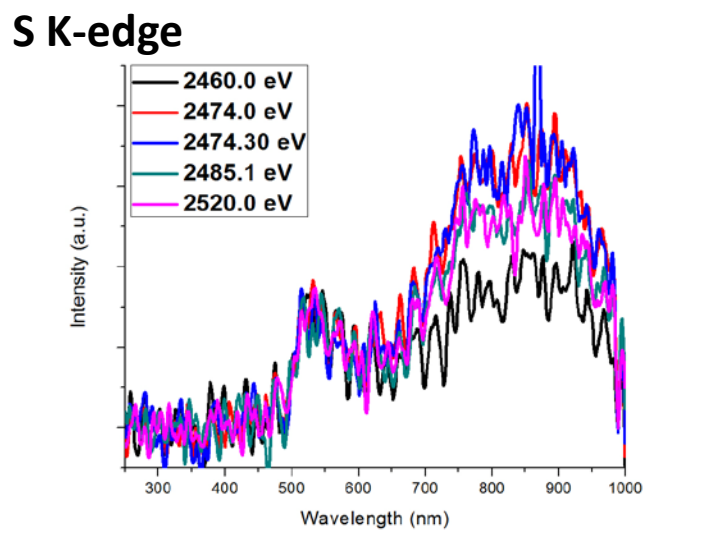
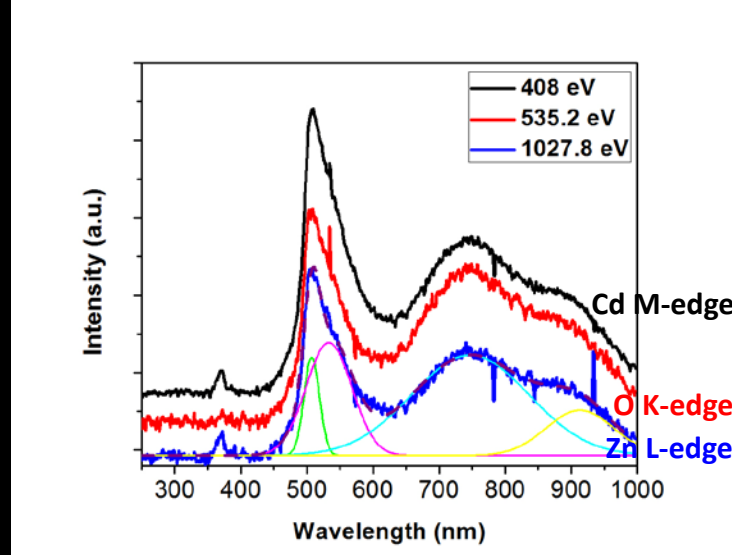
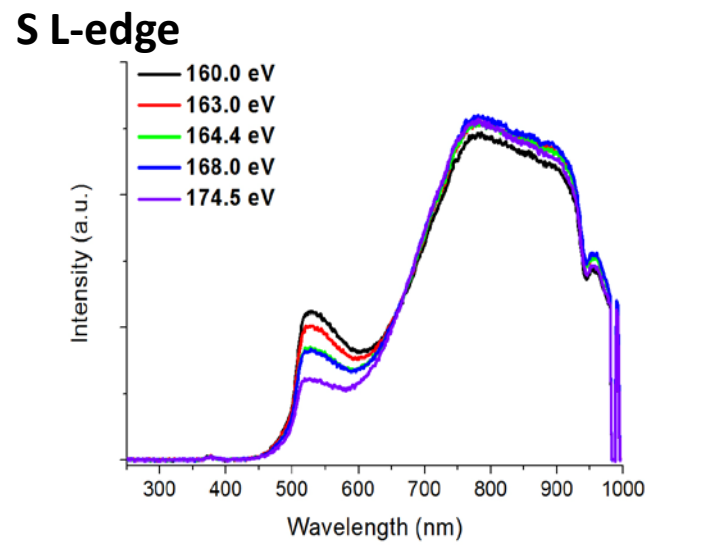


*Origin of the luminescence*

1. *Green emission ?*
2. *Red emission?*
3. *Infrared emission?*

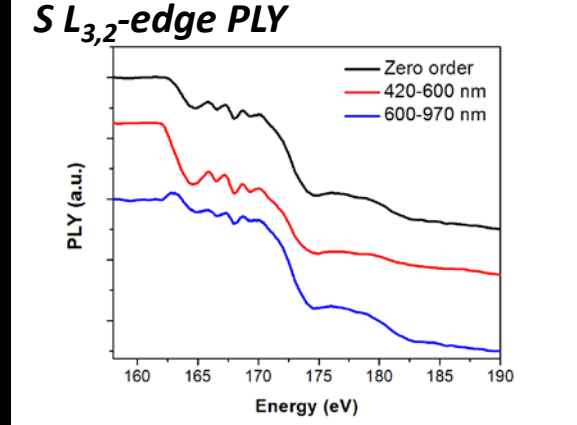
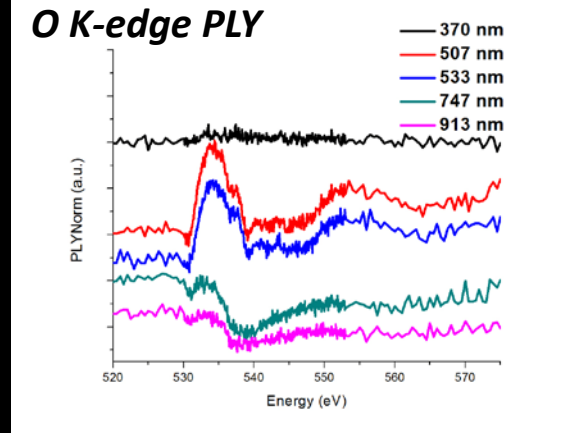
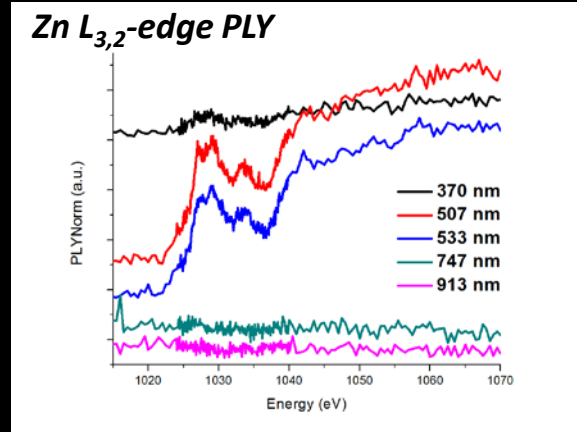
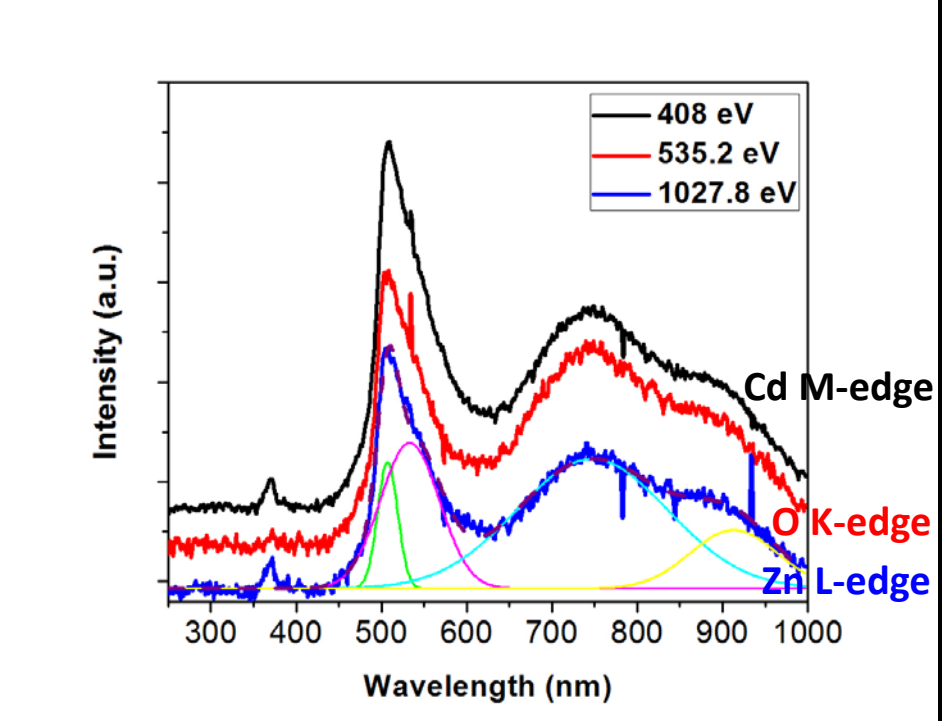
- Quenching of the BGE in ZnO
- Red-shift of the green emission
- New peaks at 747 and 913 nm

# I. Origin of the Luminescence from ZnO/CdS Nanowire Arrays via XEOL



- 747 and 913 nm peaks is related to the S site in CdS

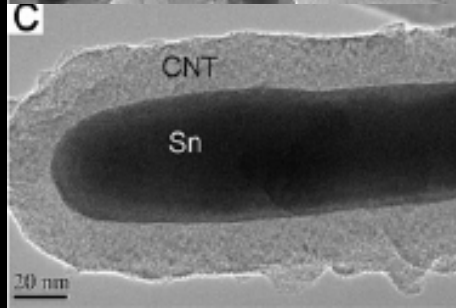
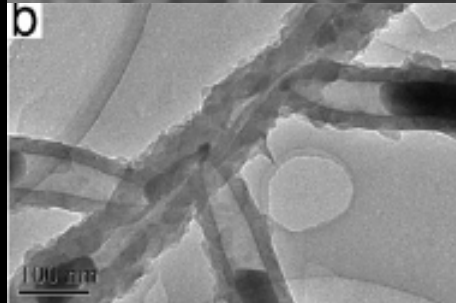
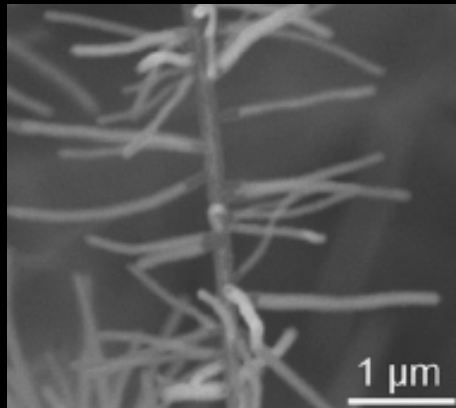
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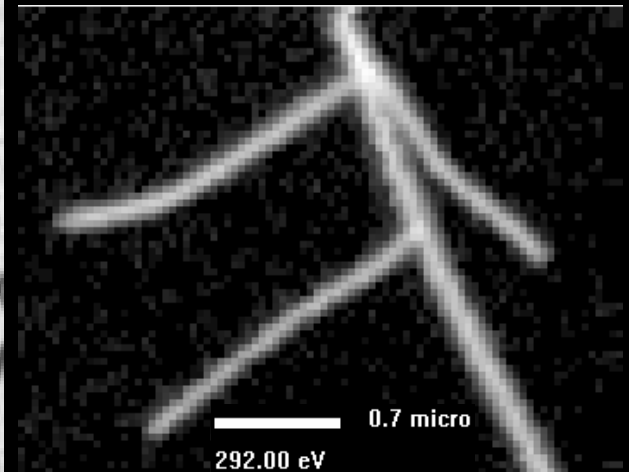
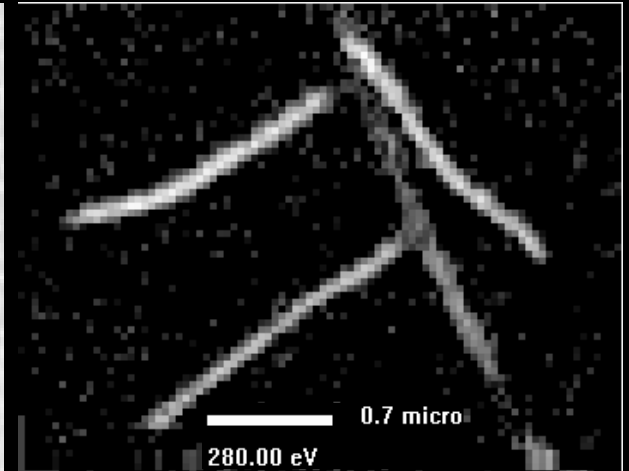
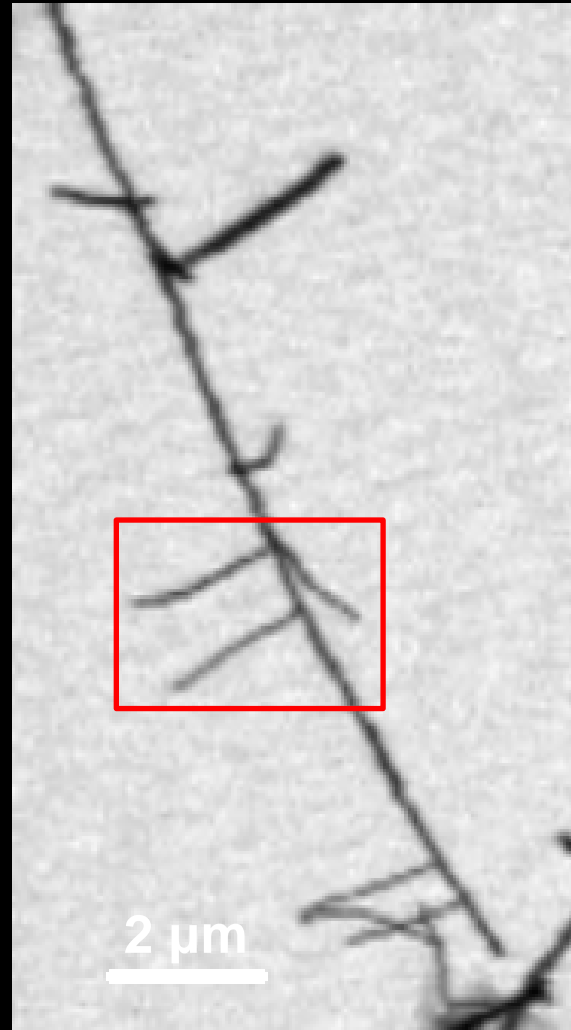
- UV emission (370 nm): NBG emission of ZnO
- Green emission
  - 507 nm peak: defect emission ( $V_O$ ) of ZnO
  - 533 nm peak: NBG emission of CdS
- Red and infrared emissions (747 and 913 nm peaks): defect emission (**S site**) of CdS
- ZnS (interface) does not contribute to luminescence

## II. STXM of branched Sn/CNT core/shell nanostructures

A120708016 – 292 eV

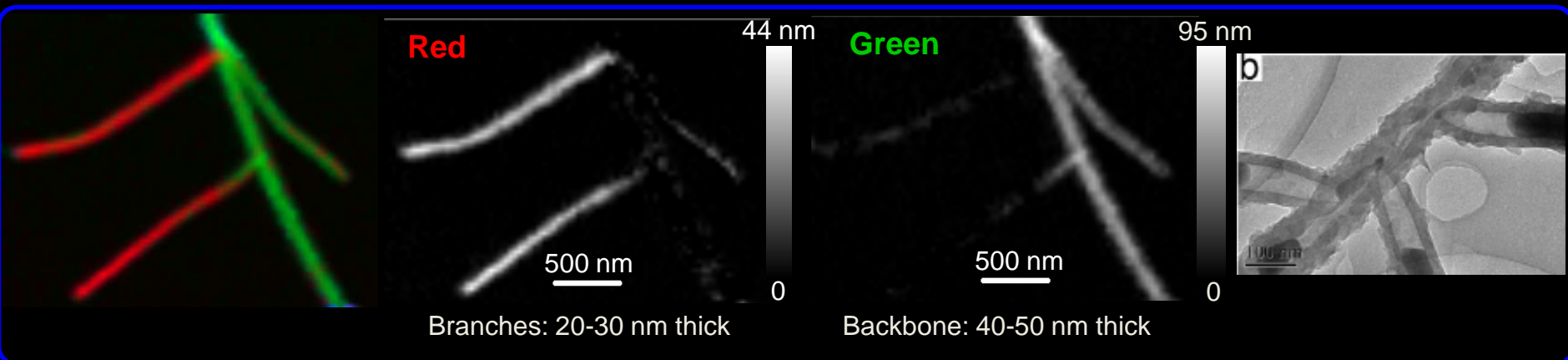
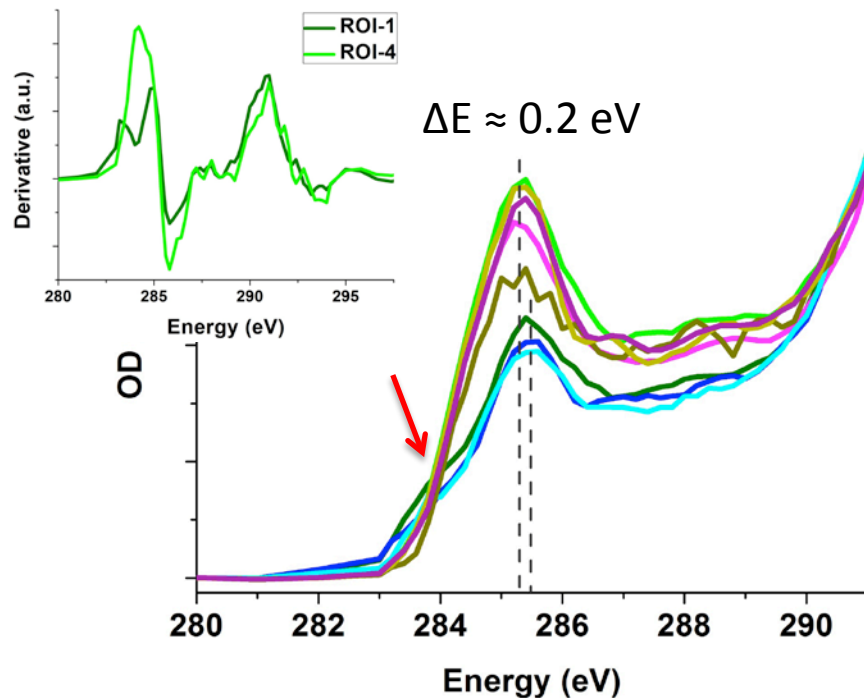
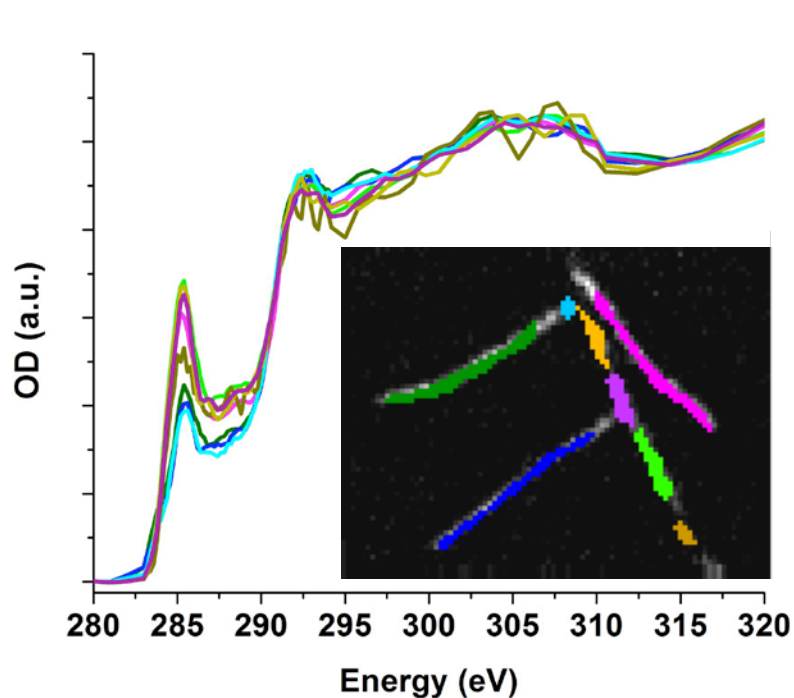


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## II. STXM of branched Sn/CNT core/shell nanostructures



# Further Plan

- ✧ Experiment - large-scale synthesis of Sn/CNT core/shell nanostructures
- ✧ Data organization
  - XANES and XEOL of ZnO/CdS nanowire arrays
  - XANES and XEOL of ZnS/ZnO nano-heterostructures with different morphologies
  - XANES of MnO films (with different oxidation states and doping levels)
  - XAS and XES of Mn-ZnO and Co-ZnO films
- ✧ STXM analysis with new software
  - Sn/CNT nanostructures
  - ZnO/CdS nanowire arrays