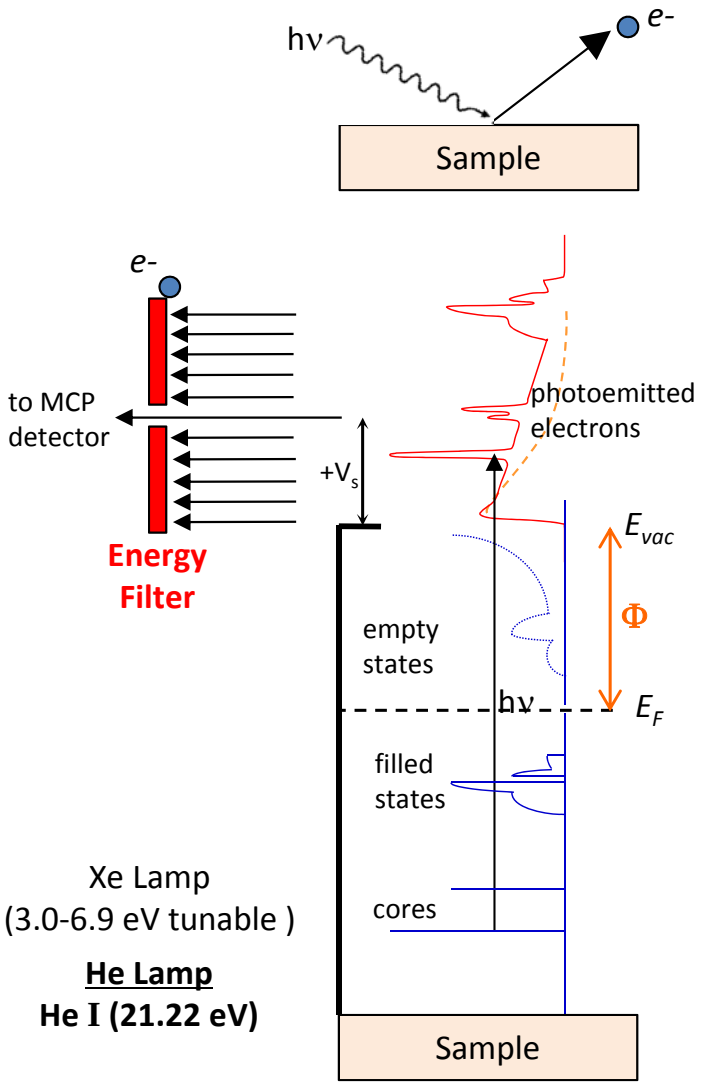
We extract the surface potential from photoemission spectra

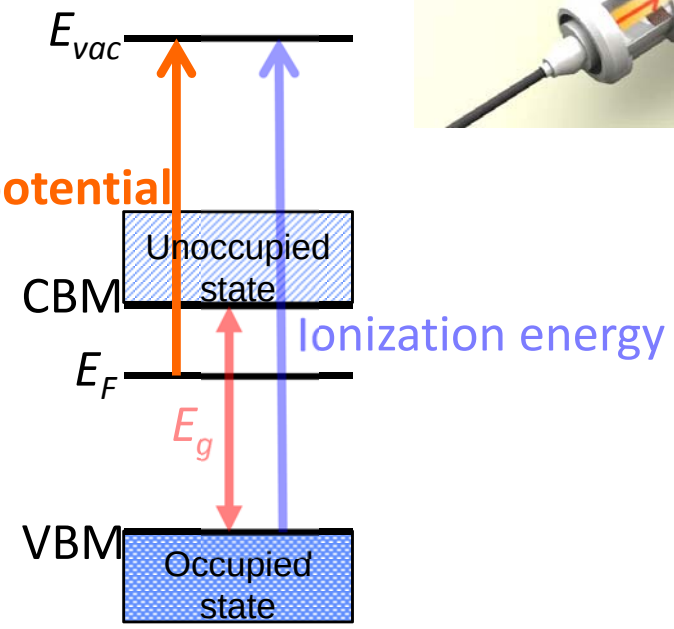
SAND2015-8179R

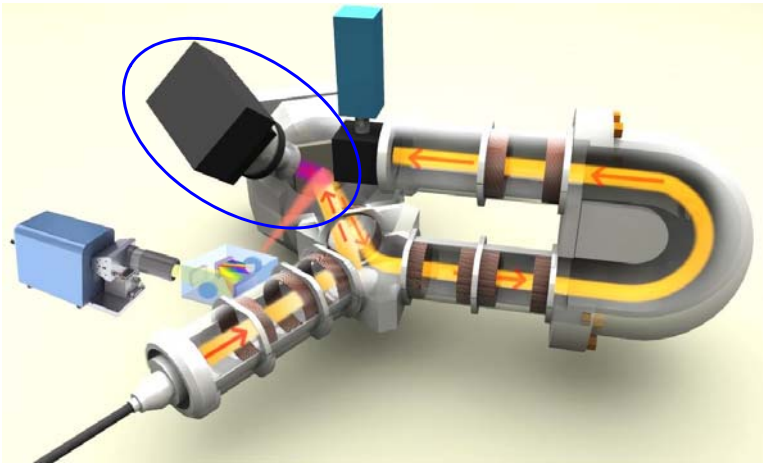
- Photoemission spectra & work function cut-off

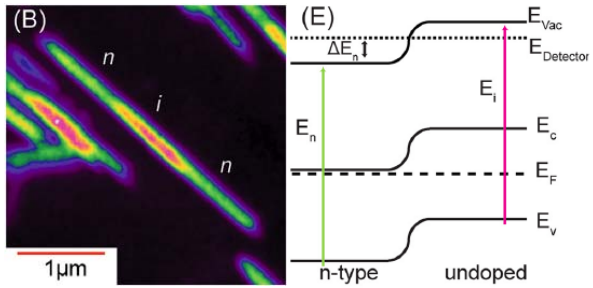


Xe Lamp
(3.0-6.9 eV tunable)

He Lamp
He I (21.22 eV)





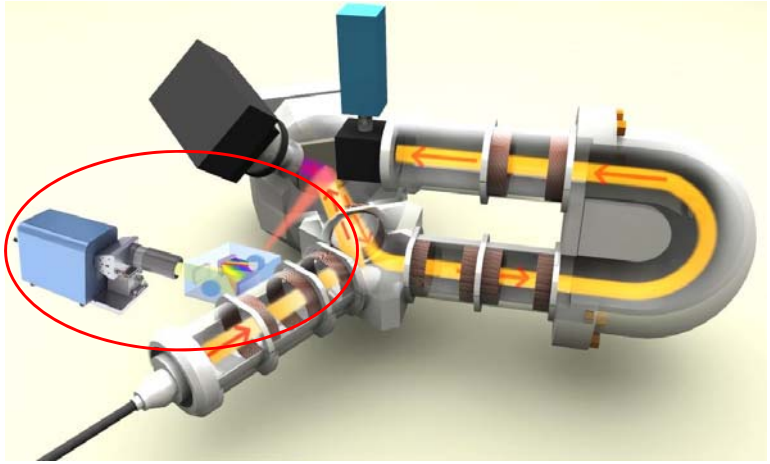


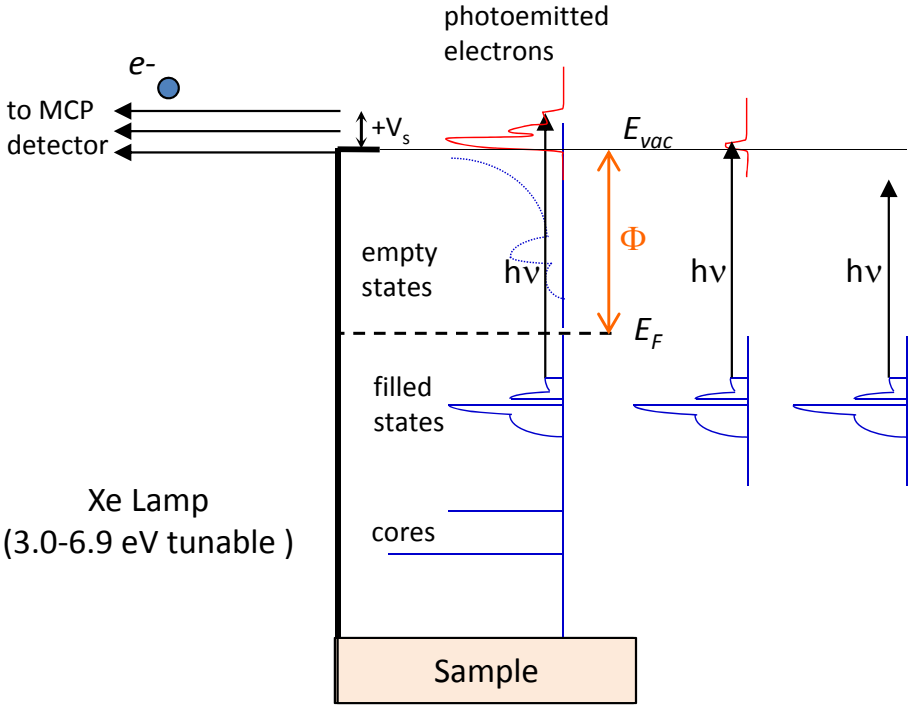
Homo-junction of GaN nanowire
Hjort et al., APL 99, 233113 (2011)

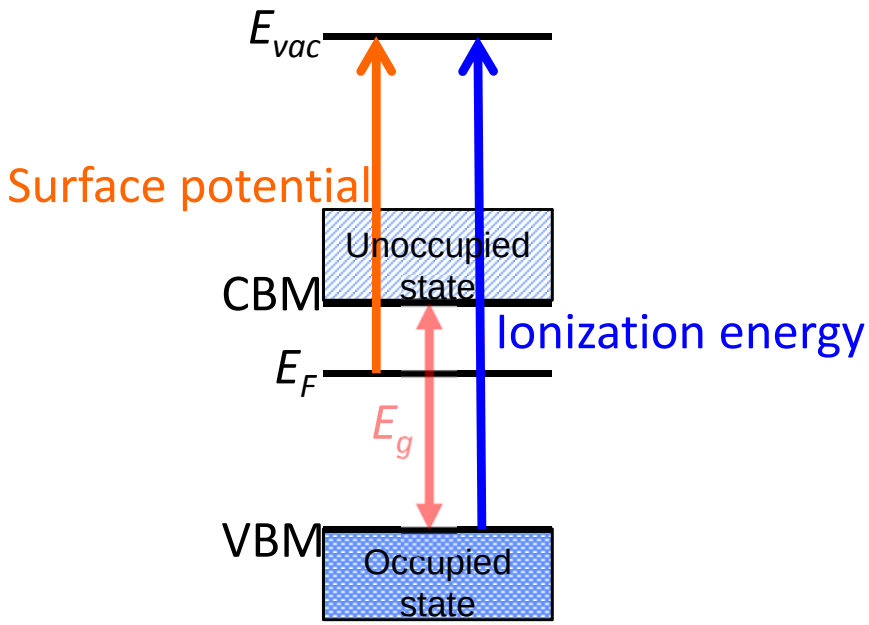
Figure courtesy: Calvin Chan

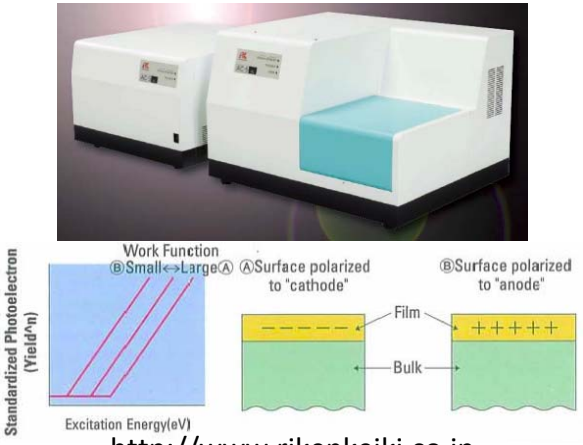
We need ionization energy to associate the surface potential to the electronic properties of semiconductors

- Threshold photoemission & ionization energy





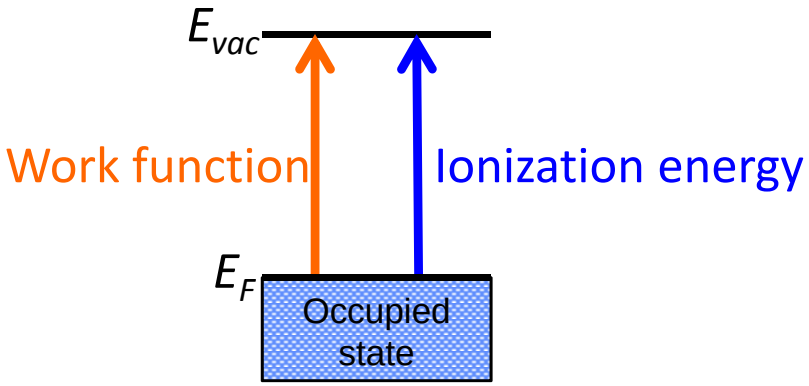


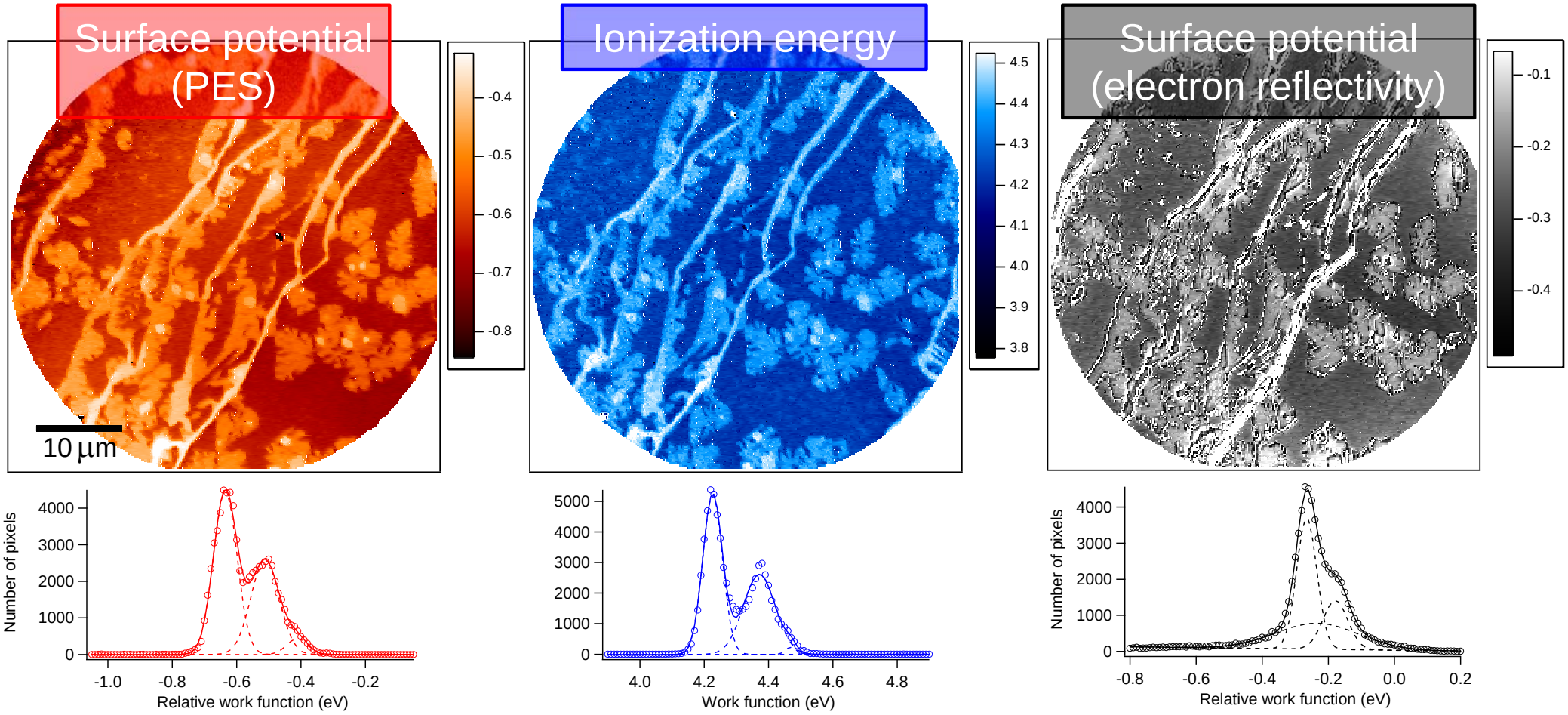


http://www.rikenkeiki.co.jp

Surface potential & ionization energy match well in metallic materials

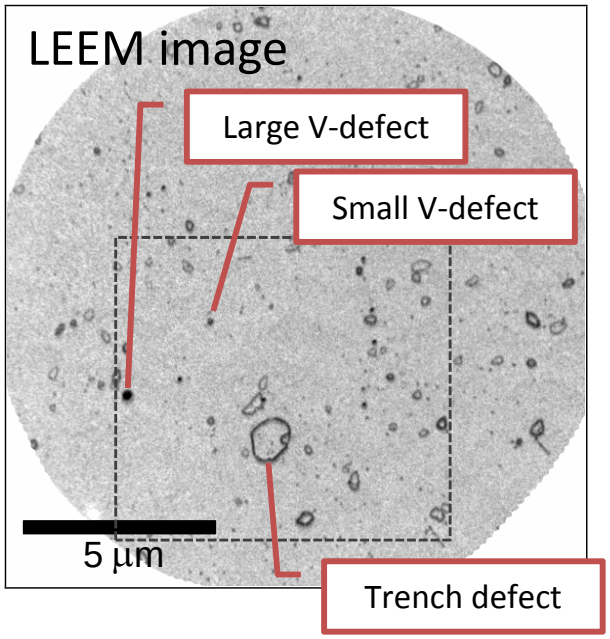
- Example of a metallic sample
  - Multi-layer graphene on a SiC substrate displays varying work function depending on the layer thickness
  - The distribution width is ~50meV consistent to kT for RT

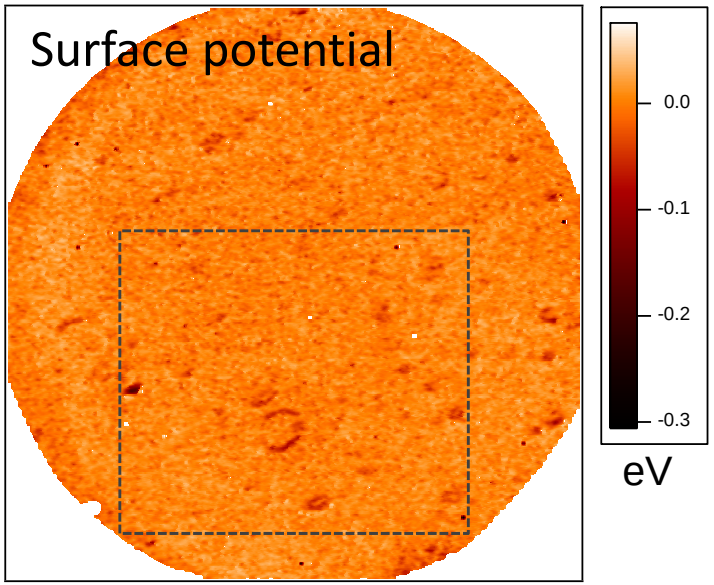


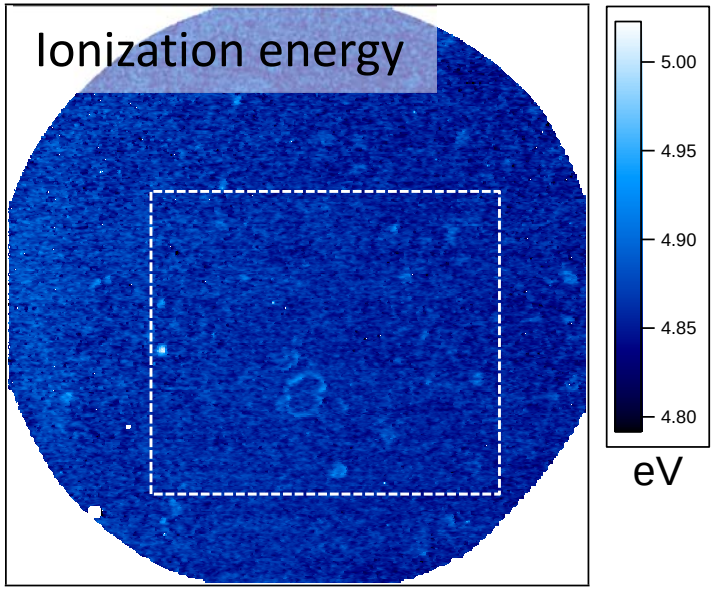


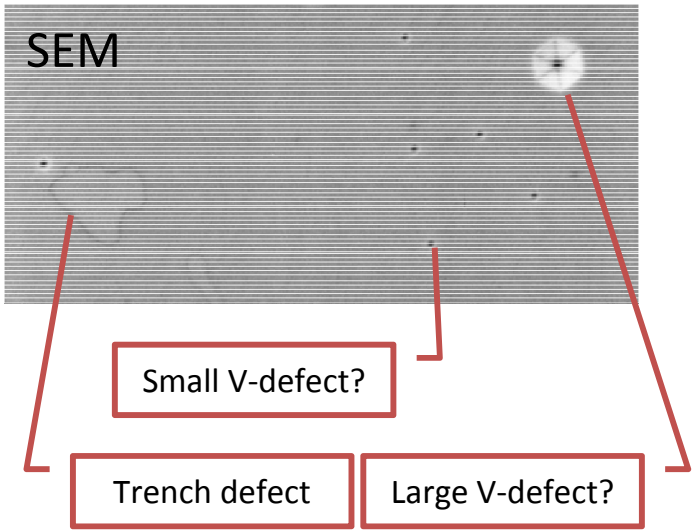
The surface potential & ionization energy vary in the vicinity of v-defects

- Defects' locations are identified unequivocally in LEEM image





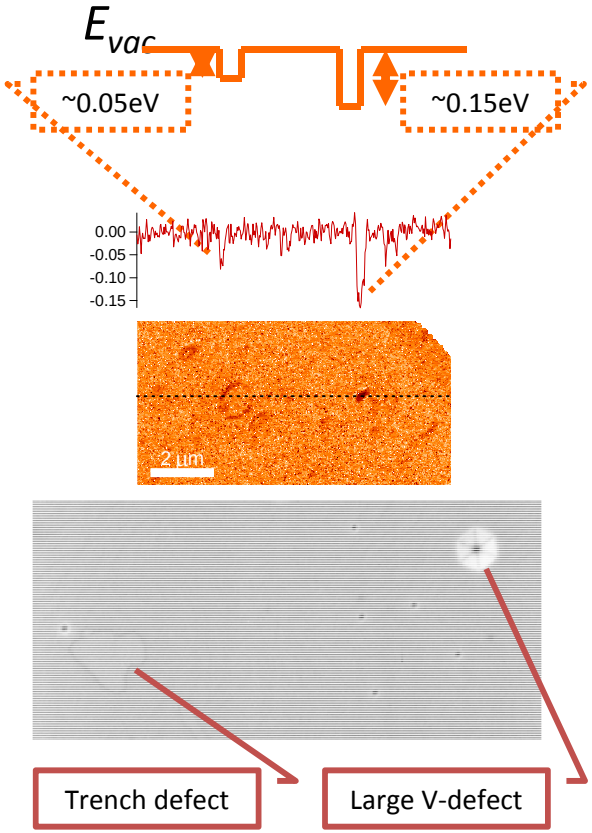




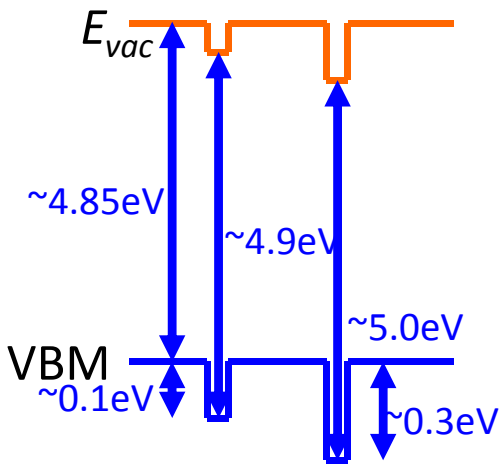
- Small v-defects & trench defects have ~40meV lower surface potential than the pristine area
- Large v-defects are ~150meV lower

Our surface potential & ionization energy measurements implies the energy barrier for holes at v-defect site

First, define the spatial variation of the surface potential (E_F is unknown)

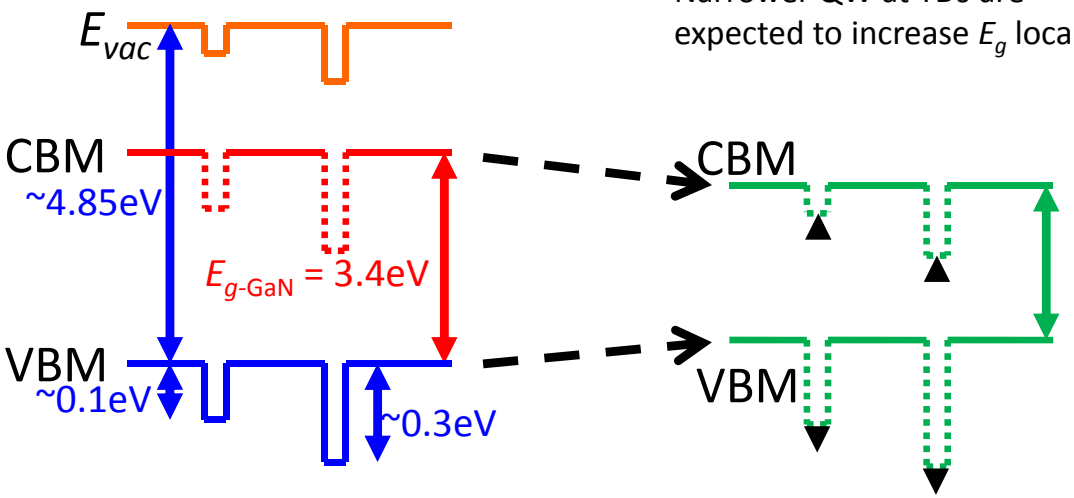


Determine the energy of the VBM w/ respect to the surface potential



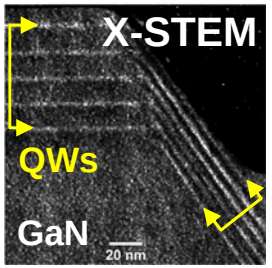
- Significant barrier heights (possibly > 0.3 eV) for holes can be expected at the vicinity of v-defects & trench defects

Define the energy of CBM based on VBM for the pristine area



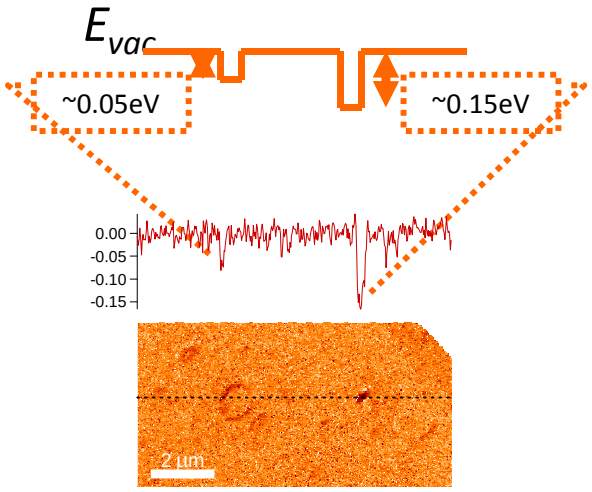
Estimate the electronic states for InGaN MQW

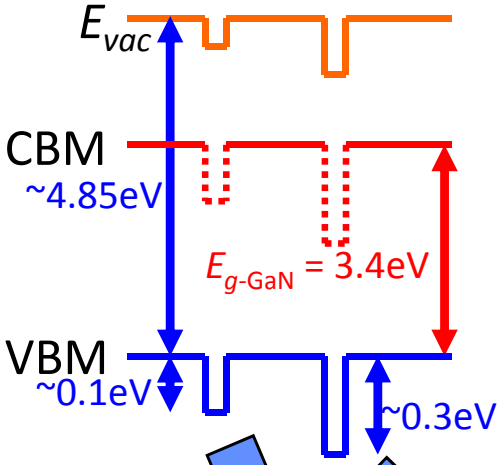
- Narrower QW at TDs are expected to increase E_g locally



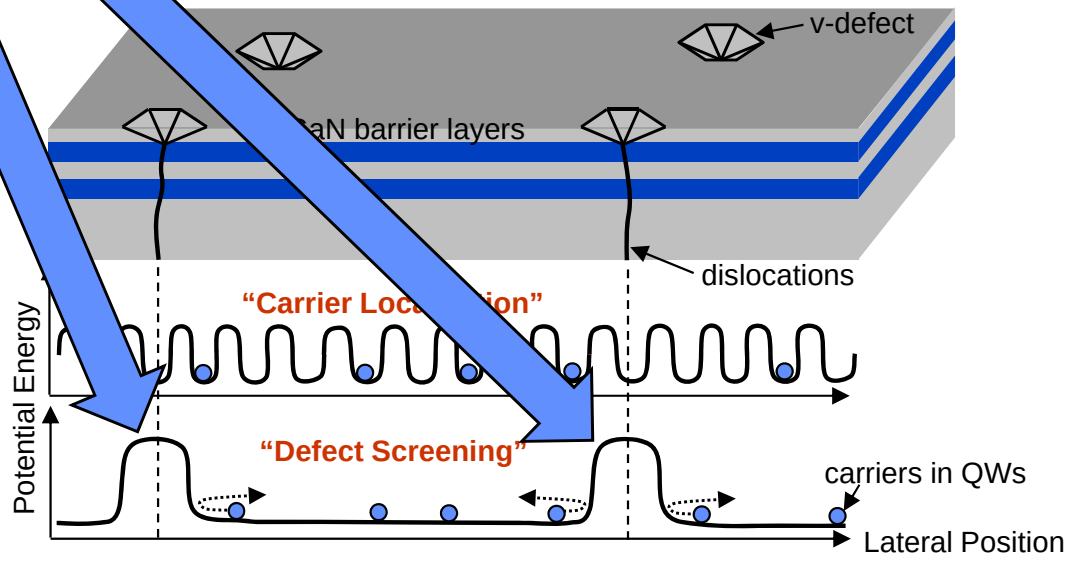
$E_{g\text{-InGaN MQW}}$ = 2.8eV for 16% indium

Our experiment suggests defect screening in MQW without compositional variation at sub-micron length-scale

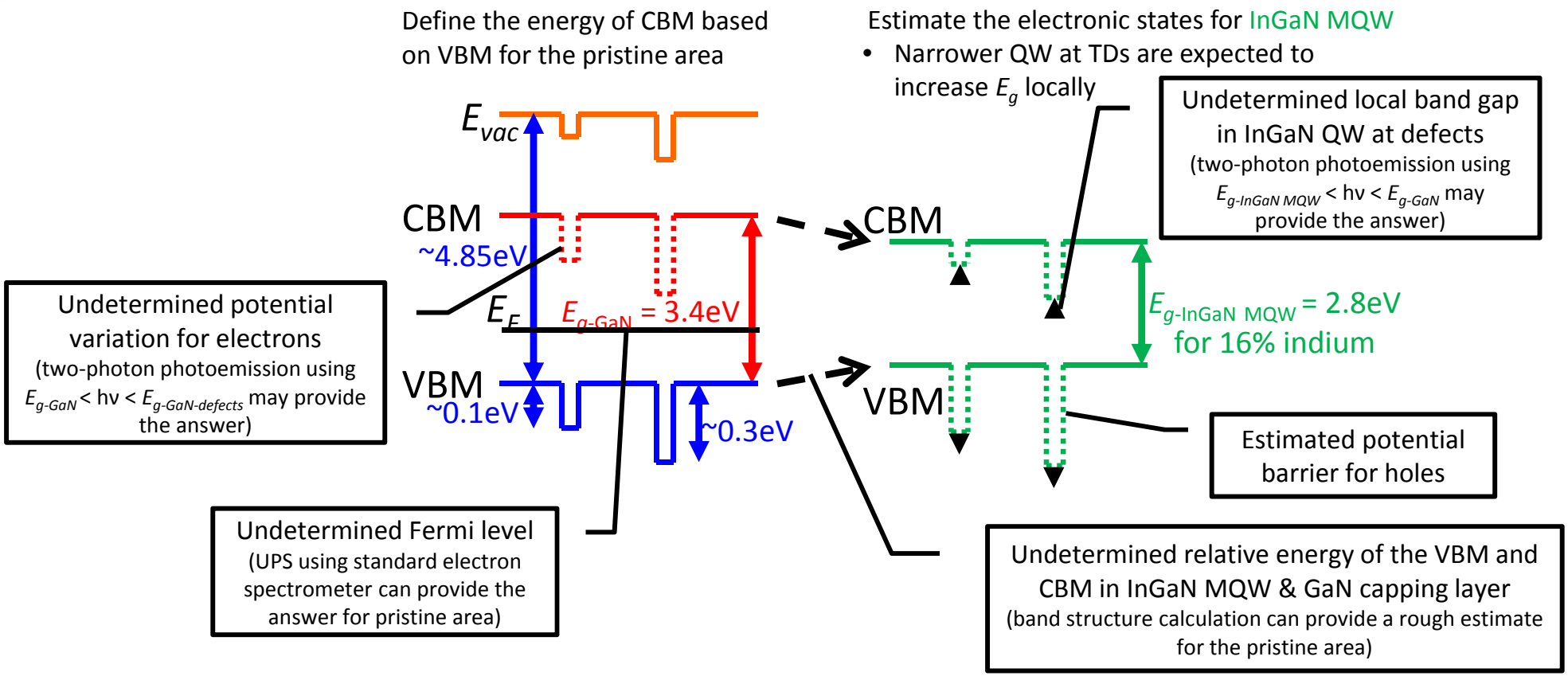




- Significant potential barrier (possibly > 0.3 eV) would keep the holes away from v-defects & trench defects



Perspectives of LEEM-PEEM research and instrumentation in the bigger semiconductor research



- Laser-based PEEM instrumentation for higher intensity and tunable photon source
  - Addressing issues related to microscope's alignment and stability
  - Use of various optical transitions to access various energy levels of semiconductors
  - Time- & spin-resolution to address the fundamental questions for materials envisioned for quantum computing
- In-operando microscopy to track device operation, chemical reaction, etc.

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