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Standing-wave assisted sub-surface imaging using photoemission electron microscopy

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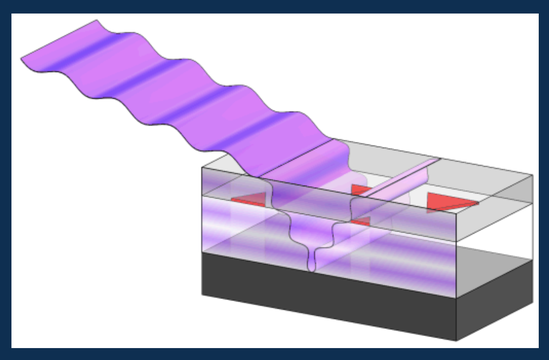
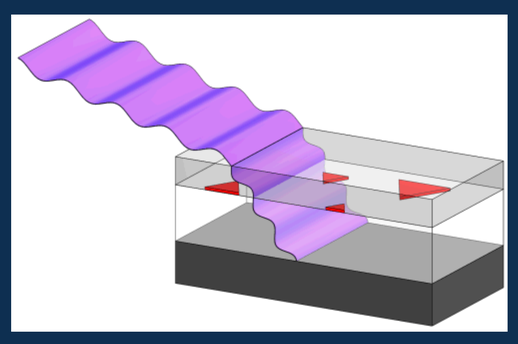
Introduction

A new electron microscopy approach to image the features buried under dielectric layers is presented. This sub-surface imaging exploits the optical standing waves formation in the dielectric layers modulating the local photoemission yield. The work presented here illustrates the examination of MoS_2 islands grown on SiO_2 substrates and buried beneath HfO_2 films. The spectra of the standing wave provide information on the dielectric environment of the buried structures.

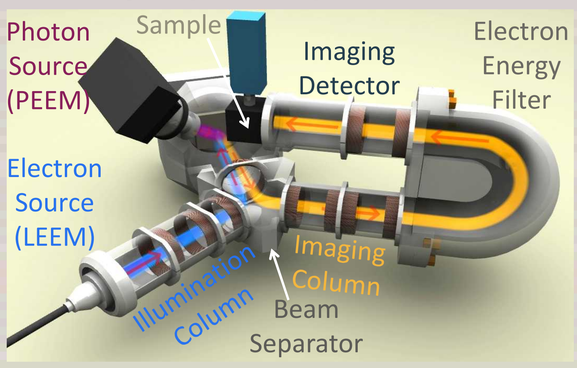




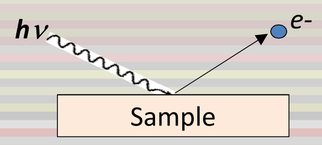
Methodology

***Approach:* Local photoemission measurement using Photoemission Electron Microscope (PEEM)**

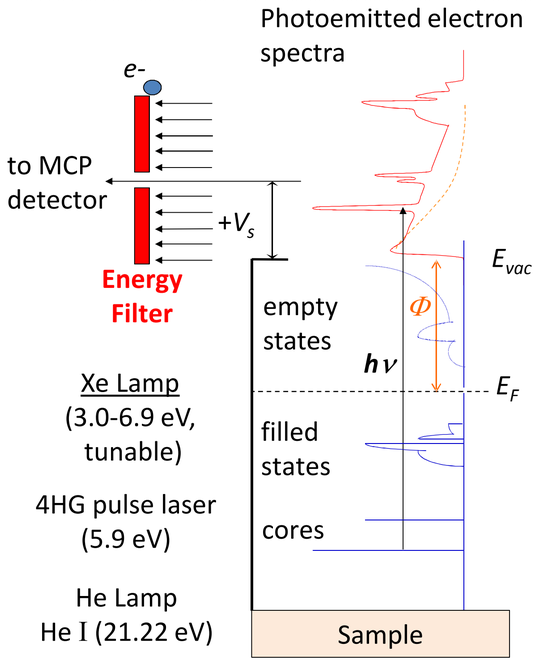
- Resolution
  - Spatial: 5 - 10 nm
  - Spectral: 50 meV
- Tunable ultraviolet light source for wavelength dependent photoemission measurement



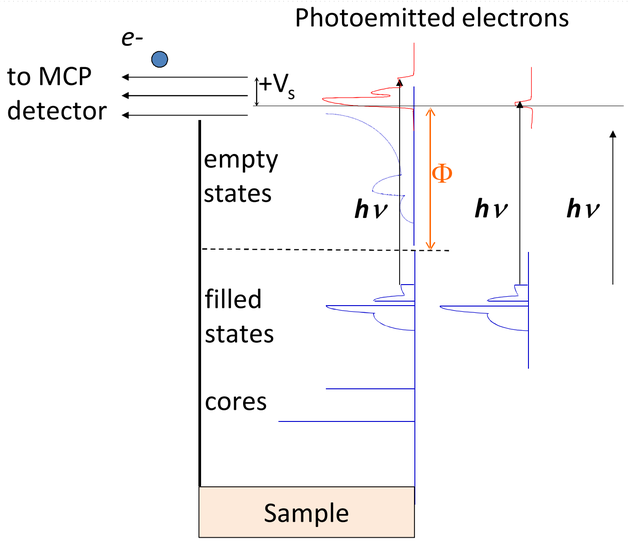
***Path:* Two spectroscopy modalities based on photoemission process**



PES: Photoemission Spectra



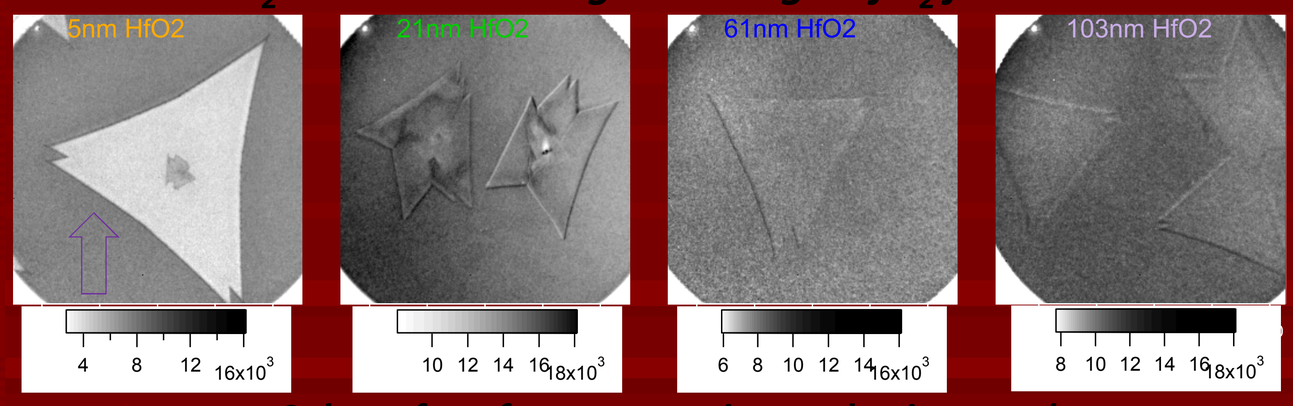
PEY: Photoemission Yield



This spectroscopy mode is used for the work presented in this poster

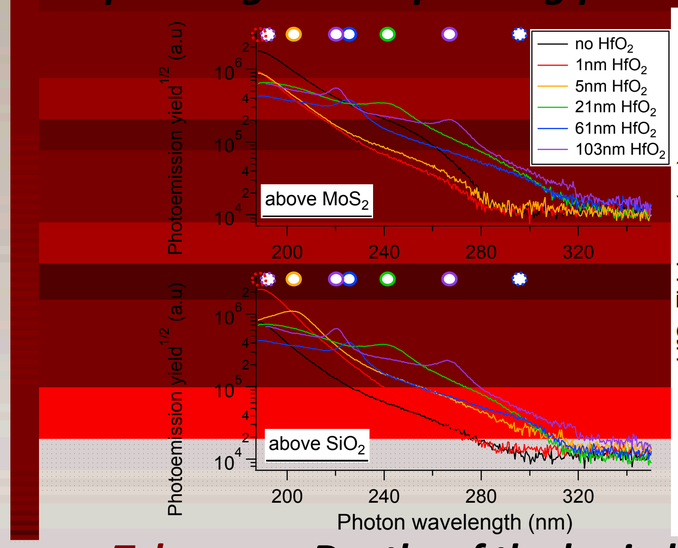
Accomplishments

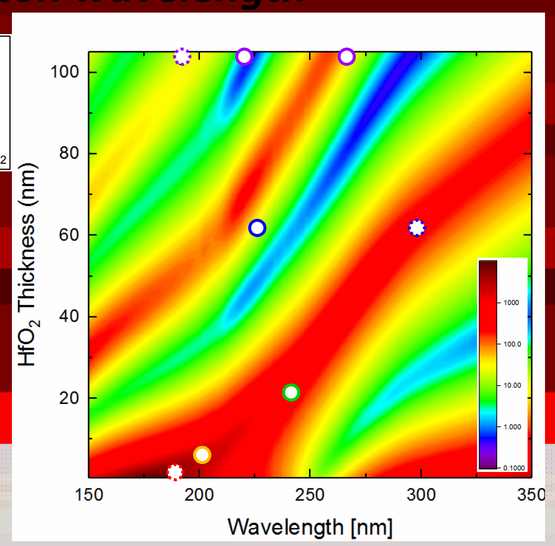
***Item 1:* MoS_2 islands are imaged through HfO_2 films**



Sub-surface features are imaged using an electron microscopy with high spatial resolution

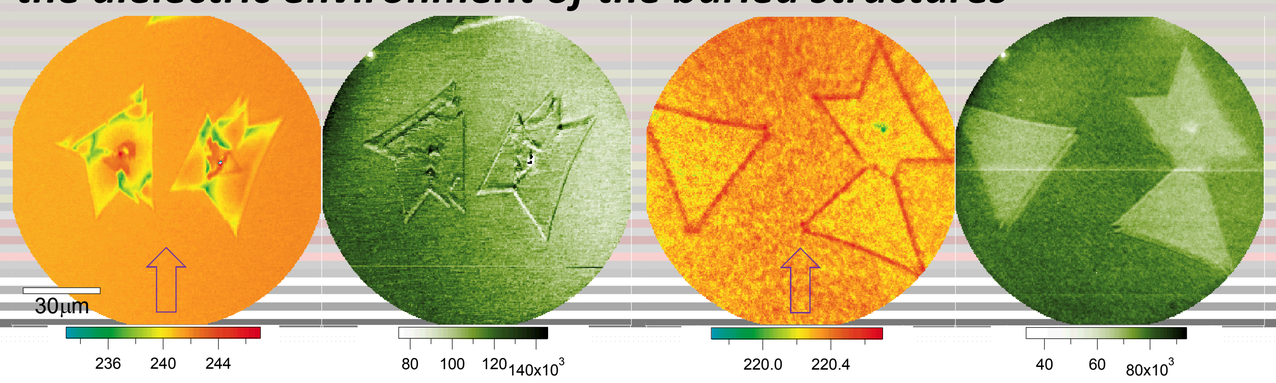
***Item 2:* Standing waves are formed in dielectric layers depending on the probing photon wavelength**





***Takeaway:* Depths of the buried structures can be deduced from the standing waves' peaks**

***Item 3:* Analyses of the standing waves provides information on the dielectric environment of the buried structures**



Future Directions

***Big Point 1:* Which dielectrics can we see through?**
Explore the kind of dielectrics that this PEEM-base sub-surface imaging can be applied.

***Big Point 2:* How does the sub-surface image vary for illumination with different polarization?**

***Big Point 3:* Can we learn about the properties of the buried materials or structures?**

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