Photoemission and Bright Beams Lab at ASU

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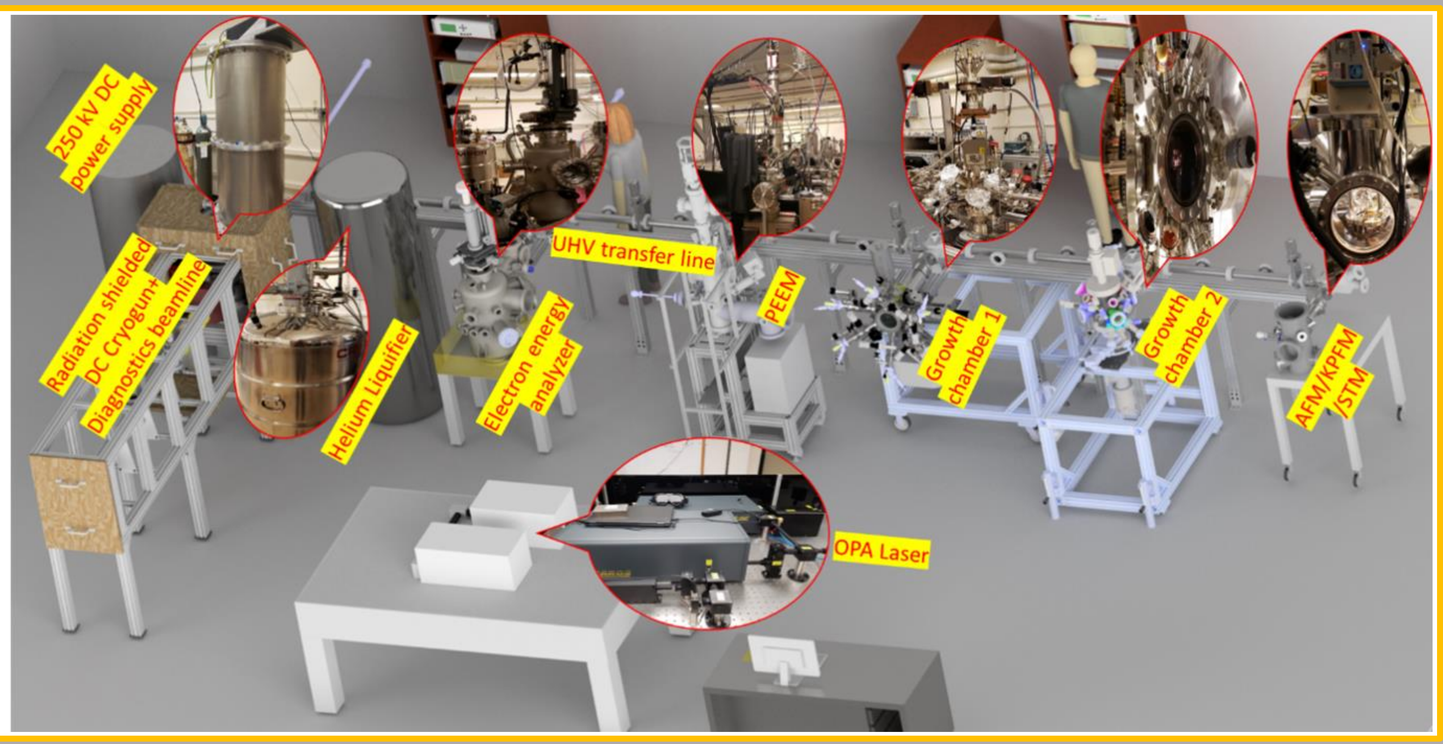
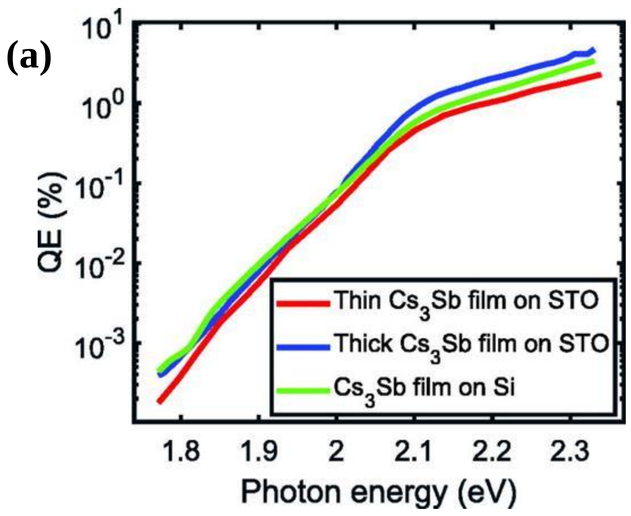
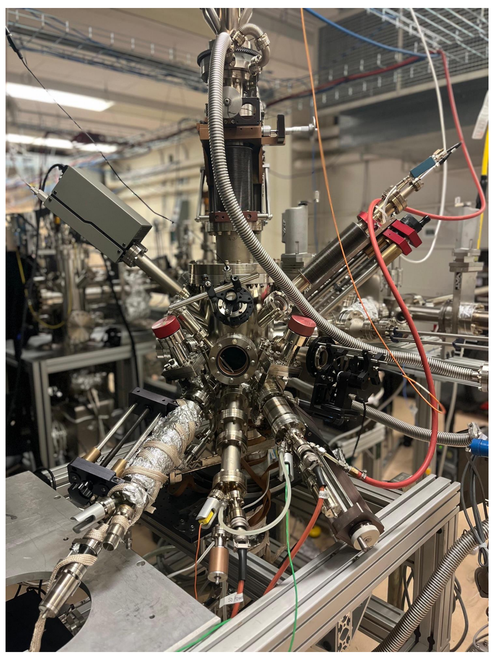
The Photoemission and Bright Beams Lab at ASU performs experimental and theoretical research to develop a fundamental understanding of light-matter interactions as relevant to the photoemission process with the goal of developing advanced electron sources for electron microscopy, ultrafast science, and nuclear and high energy physics. We employ the smoothest of atomically ordered surfaces at cryogenic temperatures under extraordinarily high electric fields along with the intense femtosecond pulsed lasers to obtain the brightest photoemission electron sources. **The lab houses state-of-the-art surface preparation and characterization facilities connected in ultra-high-vacuum to unique photoemission characterization techniques and a 200kV cryogenic DC electron gun to demonstrate the generation of the brightest possible beams.** The DC electron gun can be used to generate bright femto-second scale electron bunches to study the ultrafast dynamics of materials.



Alkali-antimonide Growth Chamber

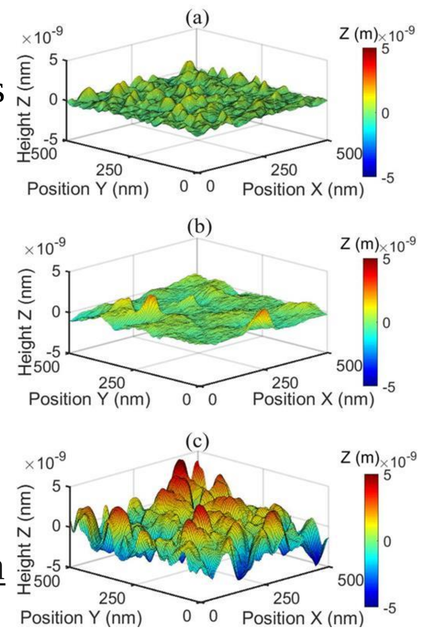


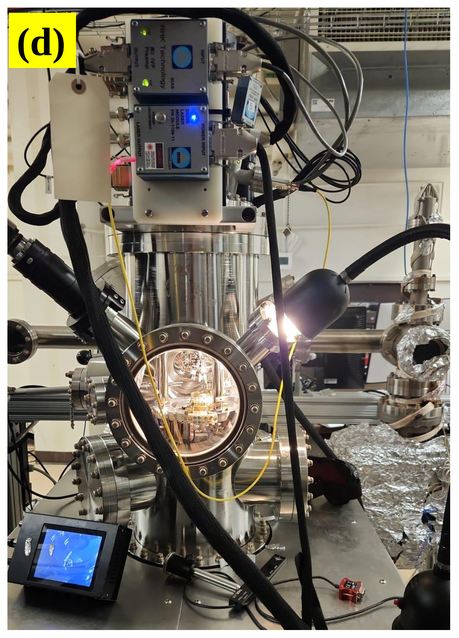


(a) QE spectral response measured from Cs_3Sb photocathodes grown on STO and Si substrates and (b) Growth Chamber.

Ultra-high Vacuum Atomic Force Microscope

Figure: 3D topography images of (a) the thin Cs_3Sb film on STO, (b) the thick Cs_3Sb film on STO, and (c) the Cs_3Sb film on Si. (d) UHV AFM chamber.





Resolution: 0.1 nm vertical direction

Photoemission Electron Microscope

Best Possible Resolution :

- Real Space: ~40 nm
- k Space 7.4 mÅ^{-1} (MTE 0.2 meV for 25 meV)
- Kinetic Energy Spectra: ~60 meV

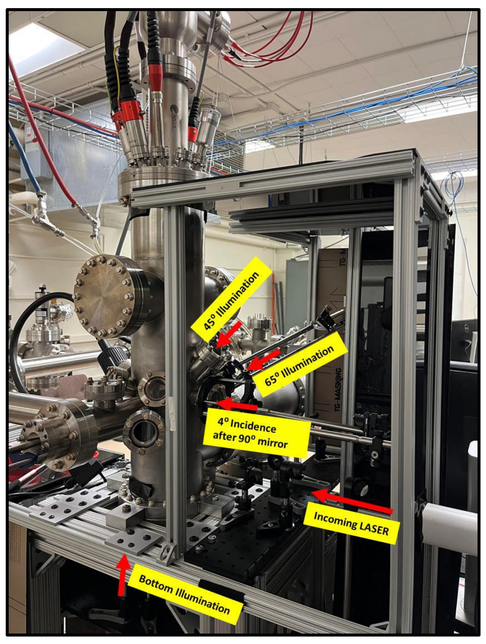
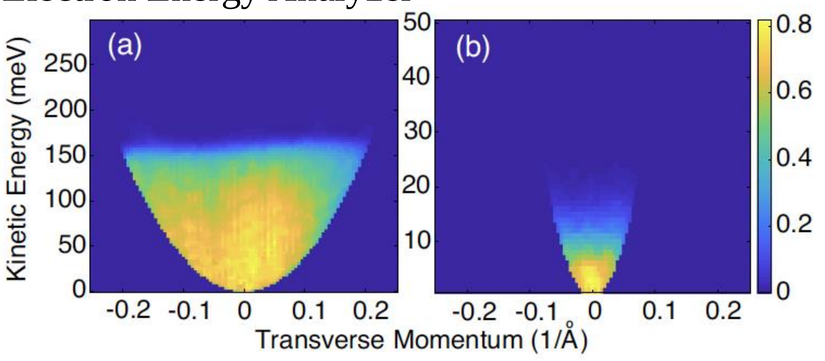


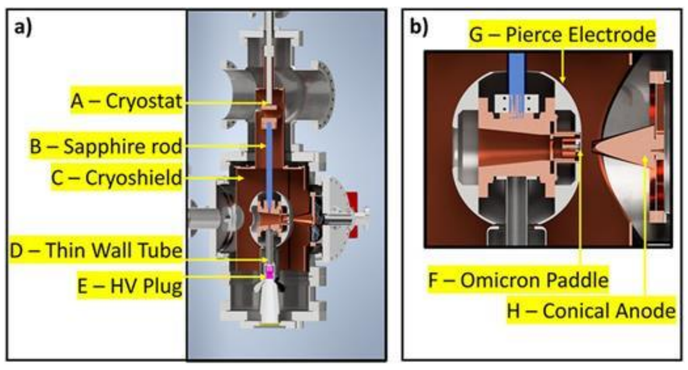
Figure shows PEEM chamber with various angles of incidence possible viz., 65°, 45°, 4° from the top after reflection from in-vacuum mirror and 0° from the bottom of the sample. The PEEM is compatible with standard omicron paddle as a sample holder.

Electron Energy Analyzer

Figure: Total kinetic energy vs transverse momentum distributions of emitted electrons using photon energy (a) 4.56 eV, (b) 4.43 eV. The transverse momentum spread with the 4.43 eV photon energy corresponds to 5 meV MTE. (c) Electron Energy Analyzer



200 kV Cryogenically Cooled DC Electron Gun



Various angles of incidence possible viz., 65°, 25.5°, 0° from and 0° from the bottom of the sample. The Gun is compatible with standard omicron paddle as a sample holder.

Figure : (a) cross-section of the ASU electron gun and (b) the internals of the core, where a custom puck is used to insert an omicron paddle mounted cathode covered by a spherical electrode with Pierce geometry. The anode is conical in shape to maximize the accelerating gradient at the cathode.

Additional and Future Capabilities

The lab is also equipped with:

- The OPA based laser (Light Conversion Orpheus pumped by Light Conversion Pharos) has been installed and commissioned in the lab space and can provide tunable wavelength pulses ranging from 200 nm to 2000 nm.
- Helium liquefier with capability to produce 26 lit/day of liquid helium.
- Future capabilities includes state of the art 200 keV UED beamline for studying diffraction from single crystal as well as macromolecular assemblies in single shot as well as stroboscopic mode.

Acknowledgements

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