Characterization of Photocathodes

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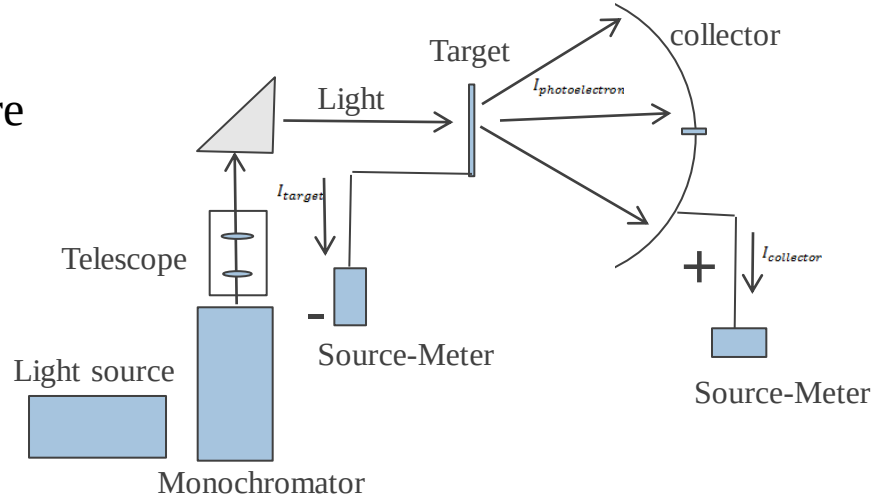
Characterization Techniques Available in Our Lab

- X-Ray Photoelectron Spectroscopy
  - Surface composition and contamination
- Ultraviolet Photoelectron Spectroscopy
  - Band structure
  - Chemical state
- UV-Vis Monochromated Light Source
  - Quantum Efficiency
- *Depth Profiling and Mass Spectrometry
  - *Mass spectrometer can be resurrected from old instrument with some financial support
  - Desorption Studies (Thermal, Electron-Stimulated, and Photon-Stimulated)

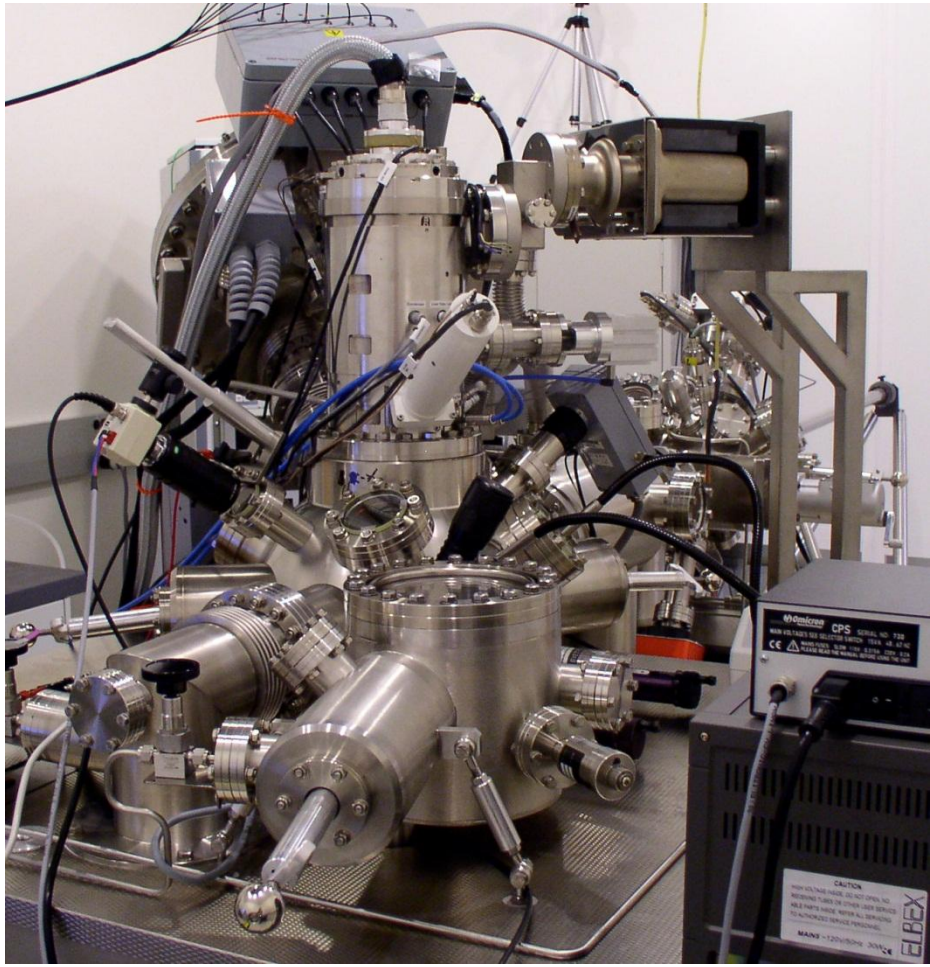
Emission Characteristics of Photocathodes

- Monochromated UV/Vis Light Exposure
  - Determine the response range of the photocathode
  - Examine aging effects of photocathode
  - Electrons can be collected with LEED screen
    - Already attached to the system
    - Energy spectrum of emission electrons can be sampled by applying a retarding potential to one of the LEED grids
  - Electron energy spectrum can be sampled using hemispherical analyzer
    - Already attached to the system
    - Better resolution than LEED screen and grid configuration



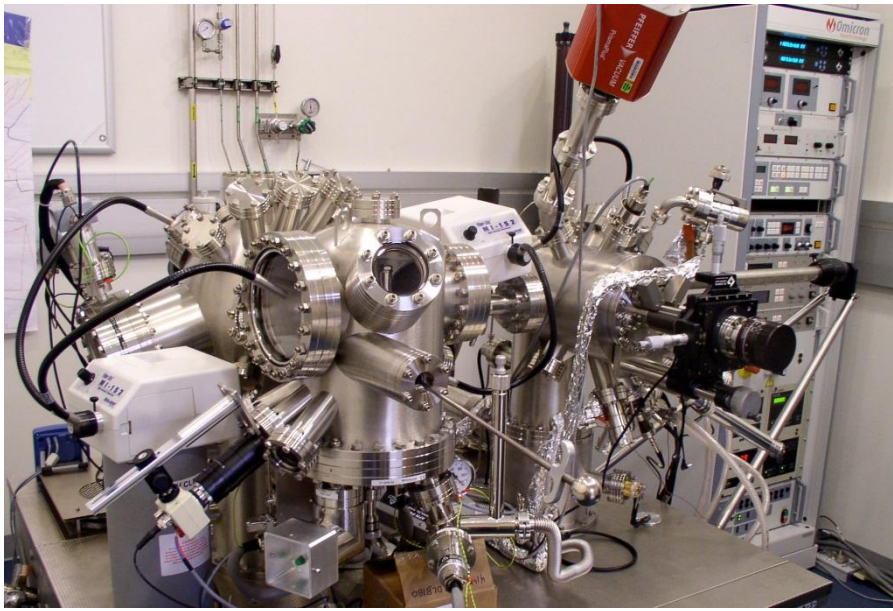
Characterization Techniques Available at CNM

- Omicron UHV Nanoprobe
  - Nanoprobes for device testing
    - Scanning Tunneling Microscope
  - Scanning Electron Microscopy
  - Low Energy Electron Diffraction (LEED)
  - UHV Gemini Column
    - Auger Electron Spectroscopy (Chemical Mapping)
    - Magnetic Imaging by SEM polarization analysis (SEMPA)
  - Sample preparation
    - Resistive Sample Heating



Characterization Techniques Available at CNM

- Omicron VT Atomic Force Microscope
  - Contact and non-contact AFM
  - Magnetic Force Microscopy (MFM)
  - Low Energy Electron Diffraction (LEED)
  - Scanning Tunneling Spectroscopy
    - Density of states
  - Host of sample preparation tools
    - Resistive sample heating
    - Direct current heating
    - E-beam heating
    - Sputter ion etching
    - Gas dosing
    - E-beam evaporation



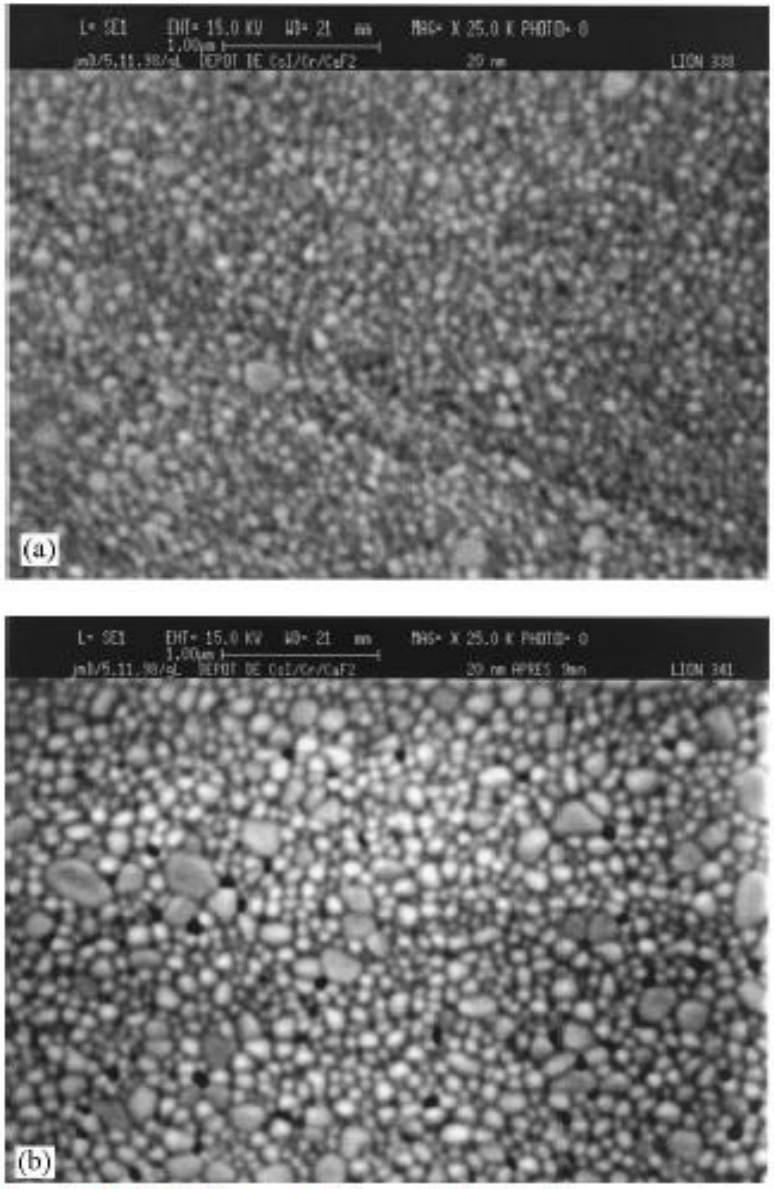


Fig. 4. An SEM view of a 20 nm thick CsI film evaporated on a CaF_2/Cr substrate: (a) "as evaporated" and (b) after exposing the sample to ambient air for 9 min. The full scale is 5 μm.

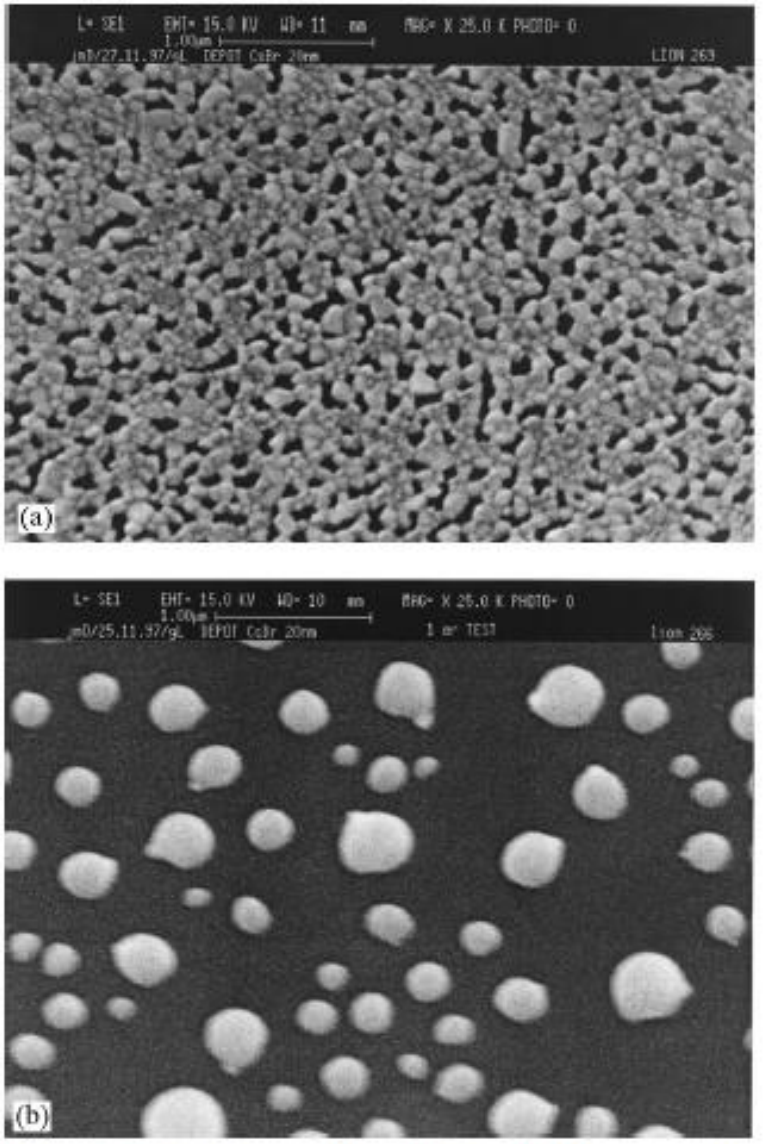


Fig. 5. An SEM view of a 20 nm thick CsBr film deposited on a CaF_2/Cr substrate: (a) "as evaporated" and (b) after exposure to Ar at 23% relative humidity, for 1 min, and to Ar at 90% for an additional minute. The full scale is 5 μm.

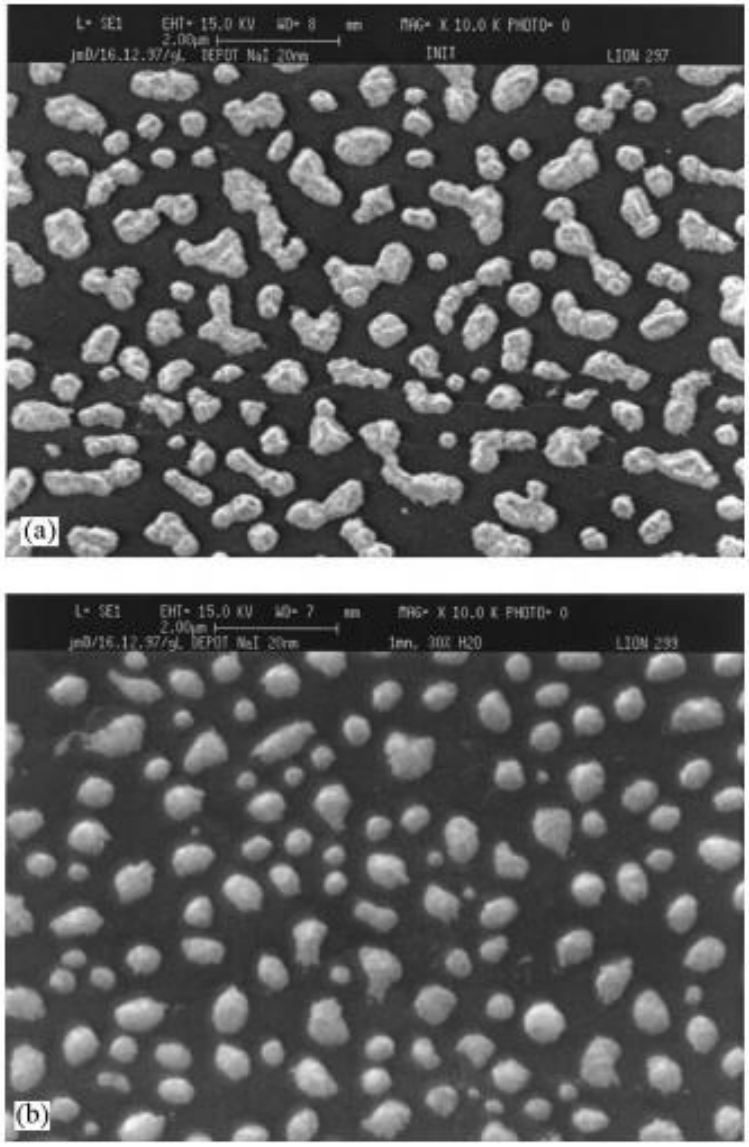


Fig. 6. An SEM view of a 20 nm thick NaI film evaporated on a CaF_2/Cr substrate: (a) "as evaporated" and (b) after exposure to Ar at 30% relative humidity, for 1 min. The full scale is 12 μm.

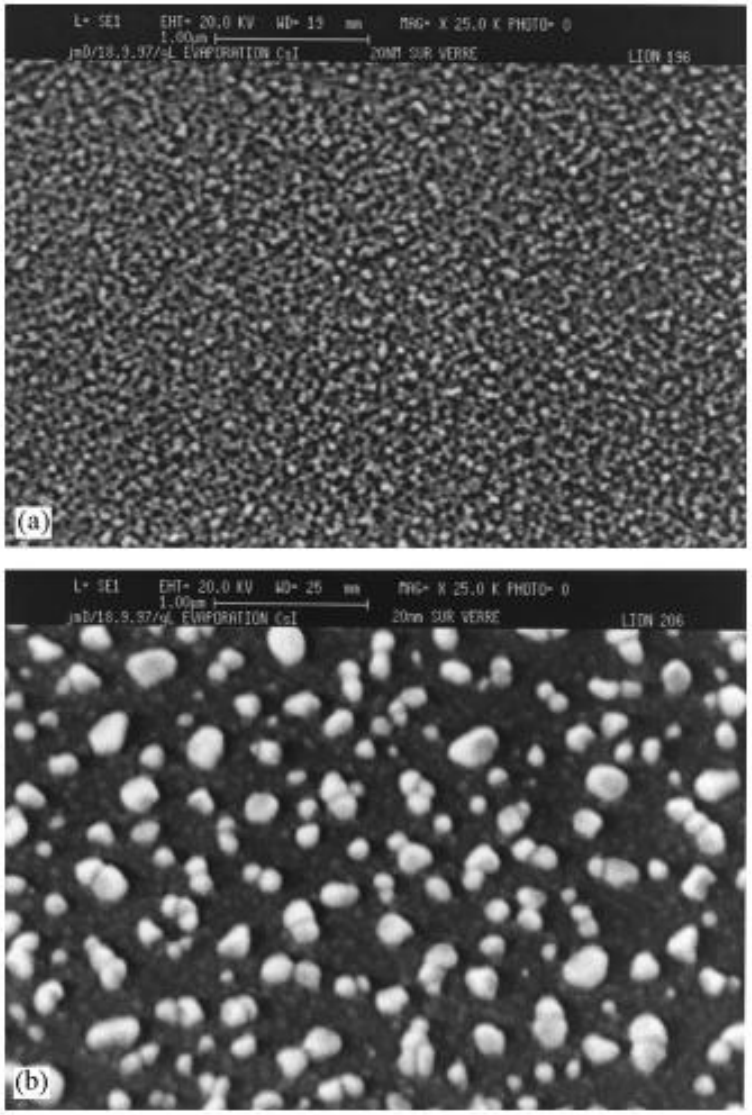
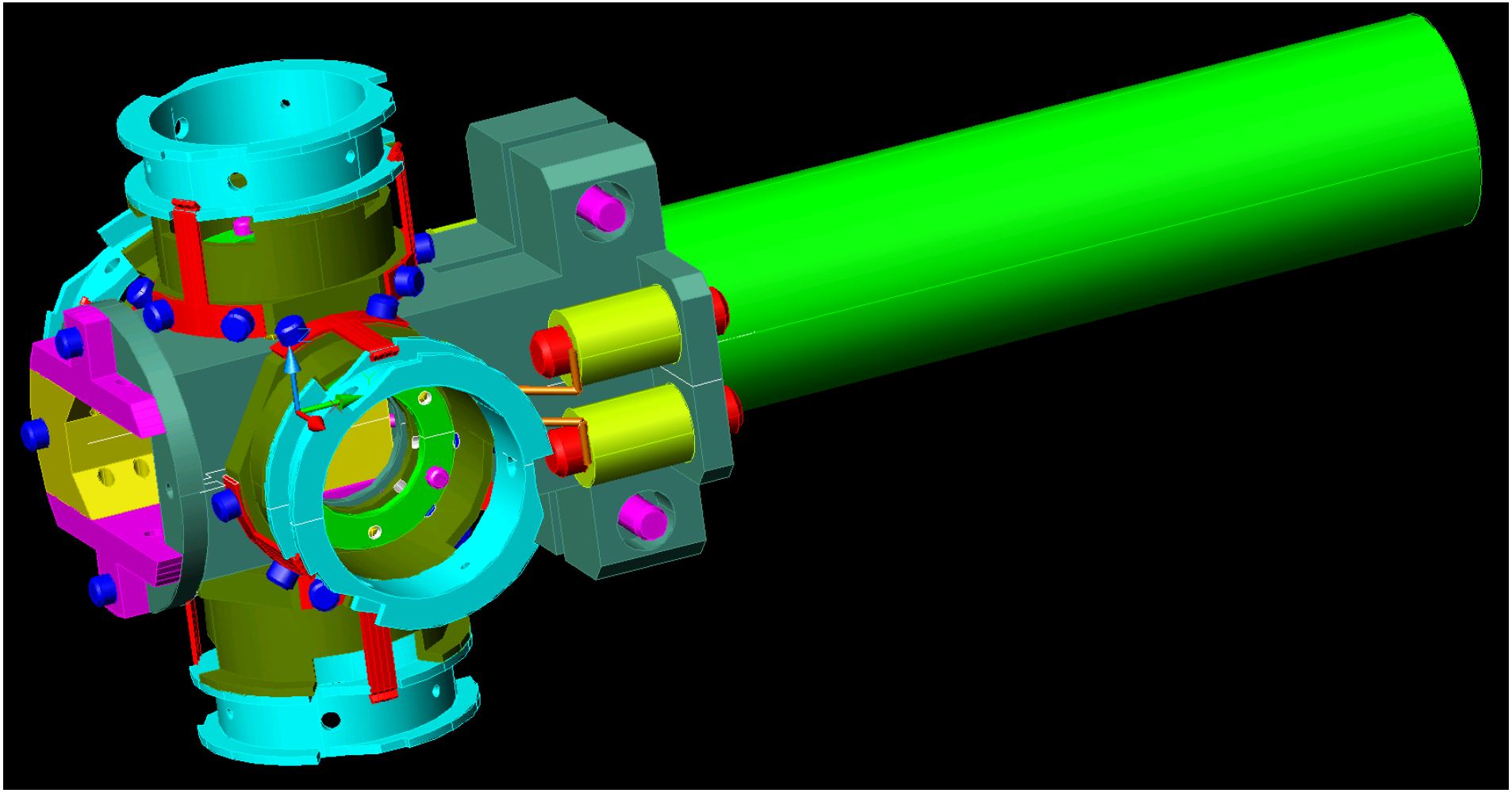


Fig. 7. An SEM view of a 20 nm thick CsI film deposited on a glass substrate coated with Au/Ni: (a) "as evaporated" and (b) after exposure to Ar at 82% relative humidity for 1 min. The full scale is 5 μm.

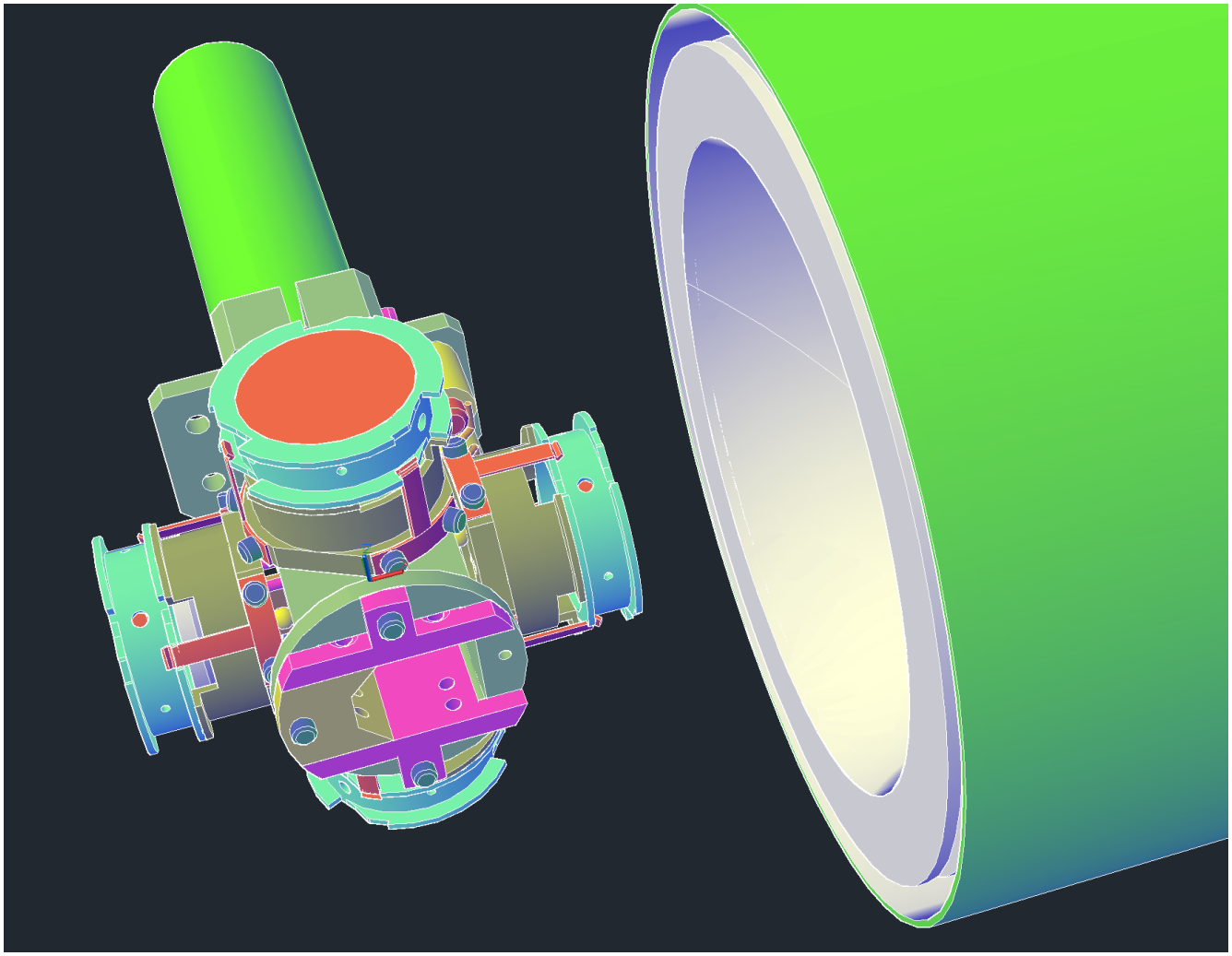
Necessary Modifications and Additions

- Monochromator and light source
  - Currently in the lab
  - Necessary to extend our current workbench to accommodate monochromator
- Multi-sample holder has been designed
- Build sample transfer container
- Add new load lock chamber to accommodate sample transfer container
- Modify current load-lock chamber to accommodate resurrected mass spectrometer for desorption studies. Add sample holder.

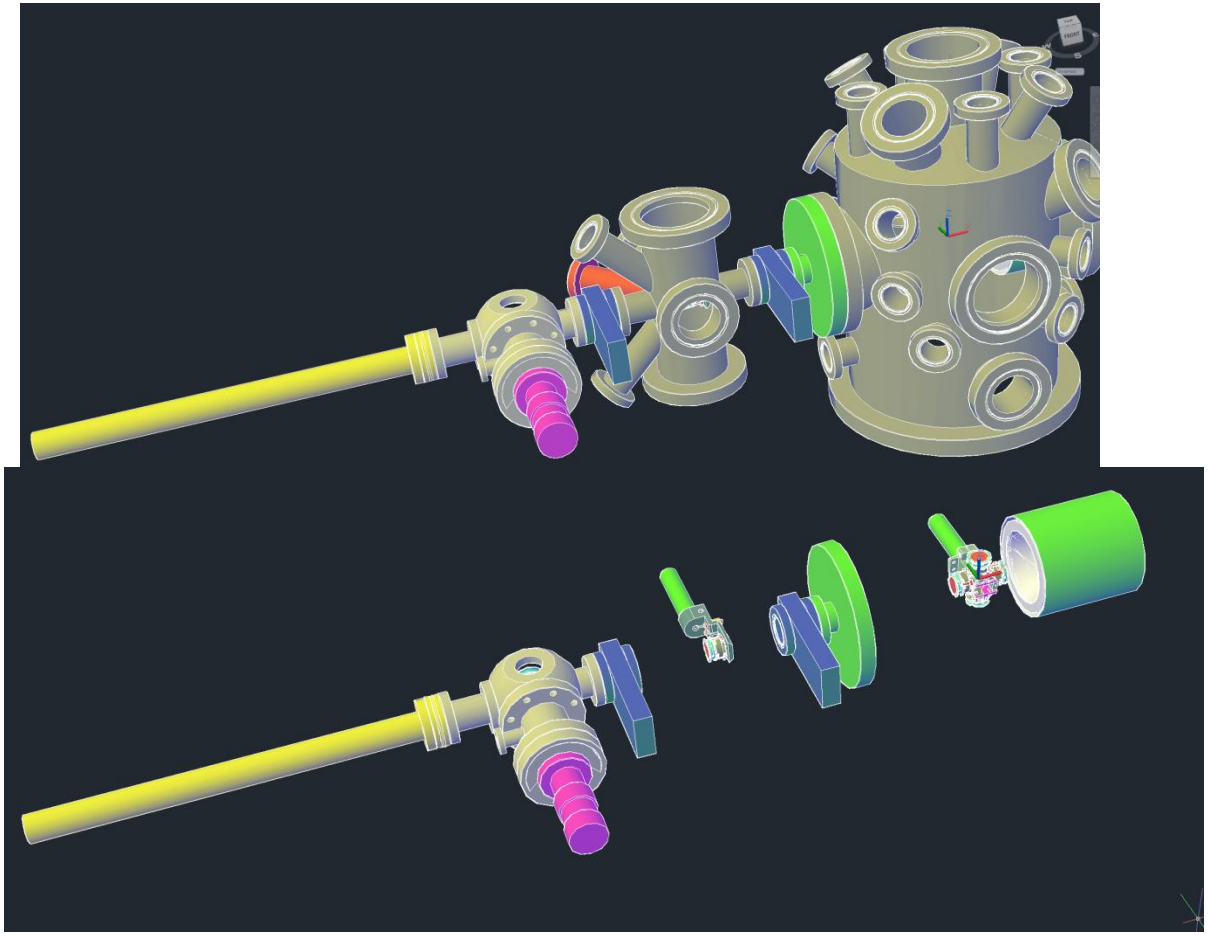
New Sample Holder Design



New Sample Holder Design

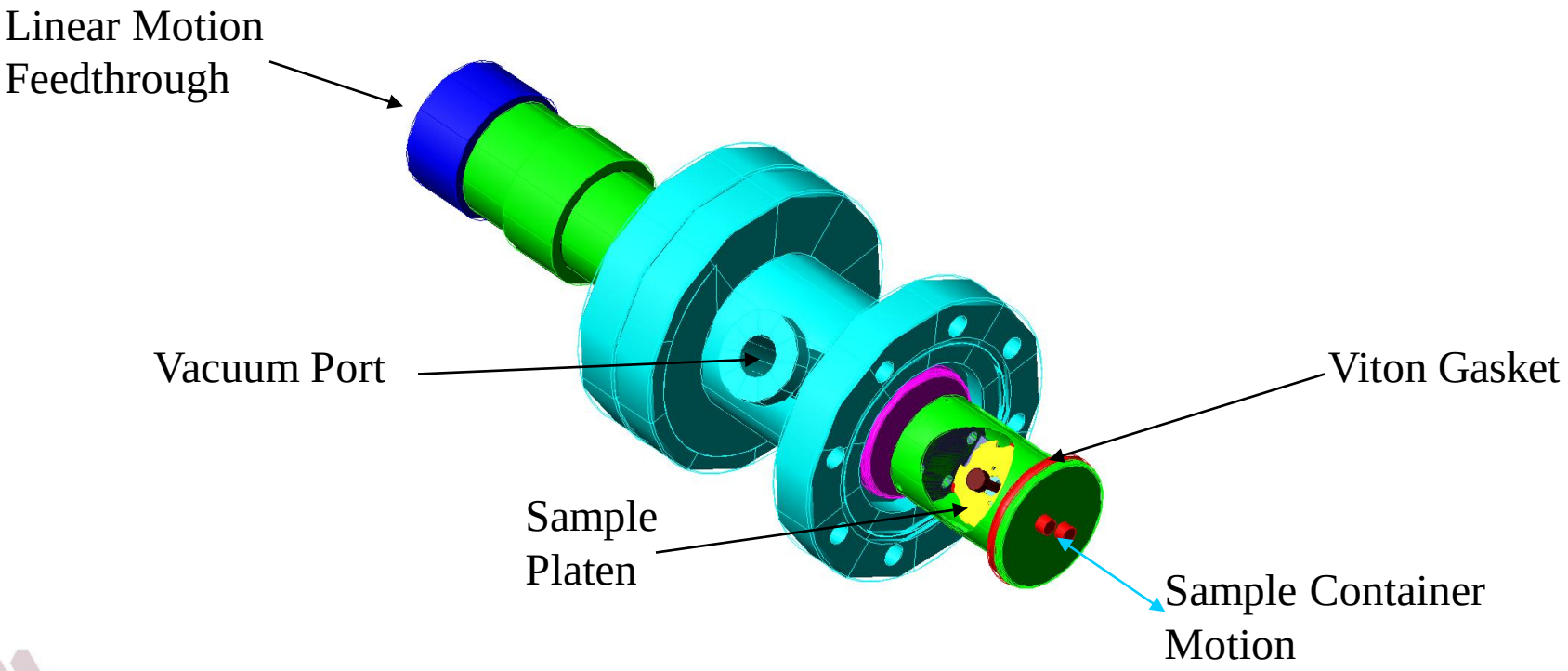


Current System plus Proposed Sample Holder Design, Vacuum Transfer Chamber, and Modifications for Sample Preparation Chamber



UHV Mobile Transfer Chamber

- Current HV design is shown below
- Must be modified to allow for UHV pump
  - Ion pump



Summary

- We can only examine photocathodes in our chamber if modifications are made
  - Sample holder must be machined to accommodate for transmission photocathodes
  - Vacuum transfer container must be built if we are to examine photocathodes without exposing them to air
  - This also requires that a new load-lock chamber be added to accommodate vacuum transfer container
- Current load-lock chamber should be modified to create a sample preparation chamber
  - Mass spectrometer for desorption studies
  - Sample holder with heater (thermal desorption)
  - Electron gun or photon source for electron or photon-stimulated desorption
  - Ar-ion source for depth profiling
- We can do basic studies at CNM, but in depth studies will require a second CNM User Facilities proposal (July 8th).