Hard X-ray Nanoprobe

HXN ID3

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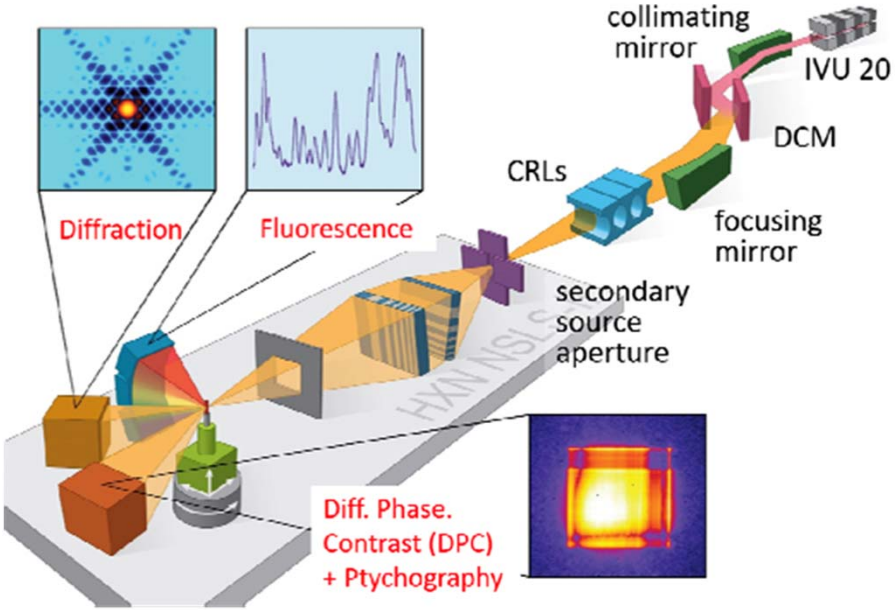
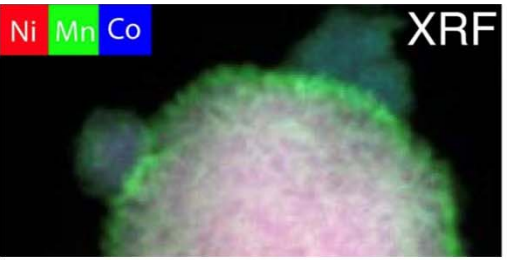
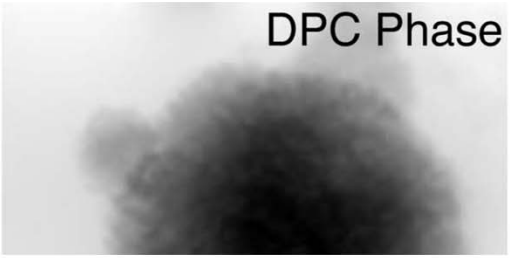
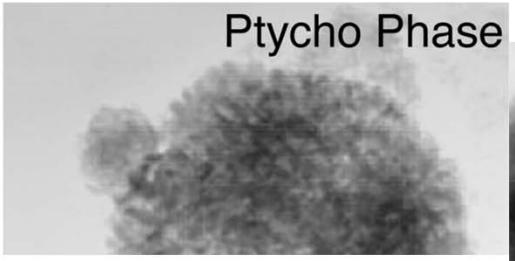
HXN Capabilities

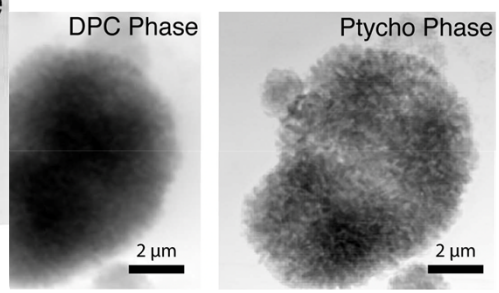
- HXN provides multimodal nanoscale characterization through scanning microscopy using focused hard x-ray beam.
  - MLL instrument produces ~10 nm beam. Truly world leading capability.
  - ZP instrument produces ~50 nm beam. Long working distance enables in-situ and crystal diffraction experiments.
- Characterization methods include
  - X-ray Fluorescence Microscopy (XFM)
  - Differential Phase Contrast (DPC)
  - Crystal Diffraction
  - Ptychography (Small angle and Bragg)
- World leading/unique capabilities
  - Routine 10 nm beams
  - Nanoprobe with Bragg diffraction capability
  - Fully integrated multimodal imaging in **2D/3D**



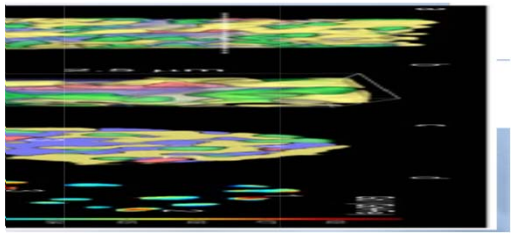




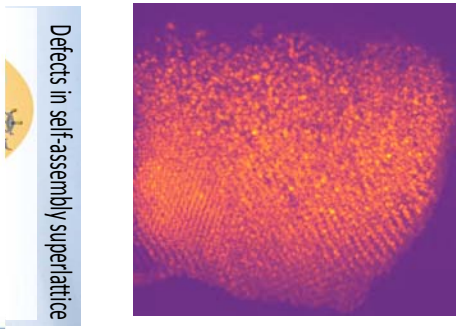




of Li-ion battery secondary
particles. (in preparation)



ic membrane for gas separation.
es that modify gas transport.



f DNA templated nanostructure

General Impressions of the Committee

- Beamline staff are extremely dedicated to establishing world leading capabilities in a unique multimodal nanoscale imaging instrument.
- Beamline staff are very highly regarded by the user community for their dedication to (often complicated) experiments.
- The instrument is a trailblazer in the field of nanoprobes.
- HXN beamline is recognized worldwide for stability and serves as a testbed for optics development.

HXN Beamline Capabilities

- Are the beamline capabilities well established and supported to meet the research needs of the intended scientific communities?
  - The impression of the committee is that HXN is creating the community through it's capabilities.
  - The current instrumentation seems best suited to materials science and condensed matter questions.
  - Biological science, potentially requiring cryo preservation for highest impact. The committee suggests that cryo-bio capabilities are not well suited to the current HXN instrument and should be pursued on a dedicated instrument.

HXN Beamline Capabilities

- Are there opportunities to enhance the existing program or pursue new capabilities?
  - In-situ science is a strength of hard x-ray instruments. With reductions in staffing at HXN in-situ has become deemphasized.
  - The committee supports additional staffing at HXN to focus on extremely challenging nanoscale in-situ experiments.
  - Spectroscopy for speciation is an underdeveloped capability at HXN. Planned upgrades to the beamline and instrument are strongly supported to enable these measurements.

Science Program and Impact

- The user communities with highest impact questions have been identified. They have successfully performed experiments at HXN.
- The committee recognizes that high impact publications are beginning to ramp up thanks to the dedicated work by the beamline staff in producing data processing tools compatible with the new capabilities of HXN.
- Staff research focused on the development of future methods is well suited to the beamline mission. Staff are clearly aware of a balance required between maturing current capabilities and investment for the future.

User Support and Labs

- Beamline staff are very highly regarded by the user community for their dedication to (often complicated) experiments as evident in the End of Run Surveys.
- The committee recognized a bottleneck to user publications in the ability to connect unique HXN imaging abilities to scientific results. A dedicated data analysis scientist (at the group level) could reduce time to high impact publications by providing post-experiment data analysis support and software development.
- Data acquisition is recognized as a severe problem, limiting experimental throughput. Problems with these system had a negative on user experience, with several users commenting on this in the end of run survey. There is also a lack of real-time support for these systems during experiments.
- HXN support labs appear to be appropriately equipped.

Partner Users

- HXN currently does not have a partner user program.
- The committee would recommend that HXN explore partnership opportunities to supplement expert staffing and develop new capabilities.

Future Plans

- HXN has well thought out beamline and instrument upgrade plans.
  - Beamline upgrades are intended to improve flux on sample, there by improving experimental throughput.
  - Instrument upgrades are planed to improve abilities.
    - Tomo stage
    - MLL bonding

- Committee recommendations
    - Focus on stabilizing current capabilities for efficient user scientific productivity.
    - A pathway should be identified to take staff R&D to user level capabilities.
    - The committee recognizes that HXN is currently under staffed considering the complexity of the experiments performed there.