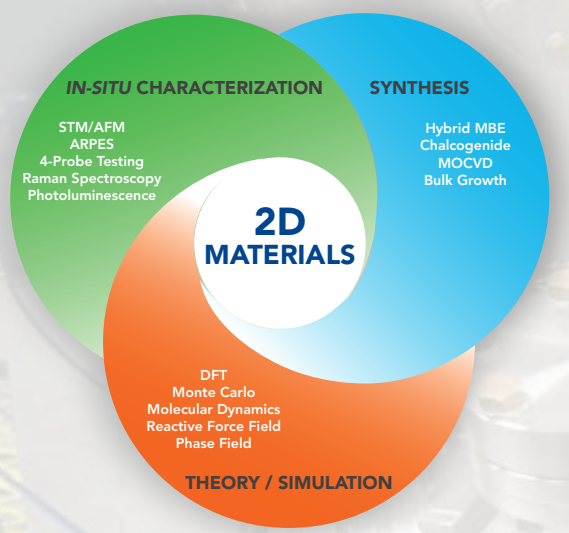
Research Focus



Approach

Close loop iterative collaboration of synthesis, characterization, and predictive modeling to accelerate discovery in 2D chalcogenides materials for next generation electronics.

Focus

Single crystal chalcogenides in monolayer, few layer, and bulk form.

Education, Outreach, and Diversity

Focused activities directly related to MIP research:

- Monthly Webinars – including tutorials, research, diversity, and inclusion
- Annual Graphene and Beyond Workshop
- Instrument Training
- Focus on broadening access to the facility and its products

Contact

Director of Education, Outreach and Diversity
Eric Hudson
ewh10@psu.edu • 814-863-5345

Become A User

The 2DCC user facilities are accessed through user proposals. Facility use is free to user PIs from U.S. academic and government institutions. Industry and international user PIs are charged a fee.

Two Proposal Types

Research projects - Synthesis, characterization, and/or theory efforts that are performed by users who come onsite or by 2DCC staff. Three-page description, plus bios.

Sample-only - Requests for standard materials routinely synthesized at the 2DCC. One-page description of the research to be performed on the sample, plus bios.

The 2DCC aims to inspire a broad range of high-quality submissions from a diverse user base. Potential users are encouraged to contact the 2DCC to discuss their ideas before preparing a proposal.

User Program Questions?

Director of Operations and User Facilities
Kevin Dressler
kxd13@psu.edu • 814-863-2867

Director of User Programs
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PennState
Materials Research
Institute

2D Crystal Consortium

NSF Materials Innovation Platform

A National User Facility Dedicated to Epitaxial and Bulk Growth of 2D Chalcogenides.

The 2DCC-MIP is funded by NSF cooperative agreement DMR-1539916.

THIN FILMS and *In Situ* Characterization

The thin film facility focuses on transition metal dichalcogenides (TMDs), topological insulators, monochalcogenides, and *in situ* growth analysis.

Chalcogenide MOCVD

- H_2Se and H_2S gas sources
- W, Mo, In, and Nb sources
- RGA for real-time gas analysis

Hybrid MBE

- 3" diameter wafer
- 4-pocket e-beam (W, Mo)
- Effusion cells for Bi, In, Fe, Se, and Te
- *In situ* spectroscopic ellipsometer (210-1690nm)
- Reflection High-energy Diffraction (RHEED)
- RGA for real-time gas analysis

Multi-Module UHV MBE Growth and Characterization System

Available in early 2018.

- 6-pocket e-gun source (Fe, Nb, V, W, Mo EuS)
- Se cracker, effusion cells for Te, Bi, Cr, Sb, Fe
- *In vacuo* STM and ARPES

Chalcogenide MOCVD System with *In Situ* Optical Characterization

Available in summer 2018.

- 8 bubbler stations and 4 gas sources including H_2Se and H_2S
- *In situ* spectroscopic ellipsometry (210-1690nm) laser reflectometry, Raman/PL

Contact

Joan Redwing / Director, Synthesis Lead
email: jmr31@psu.edu

Nitin Samarth / Assoc. Dir., Characterization Lead
email: nxs16@psu.edu

BULK CRYSTAL GROWTH

The bulk crystal growth effort is focused on binary TMDs, TMD alloys and dopants, and chalcogenide-based topological insulators.

Bridgman

Vertical Bridgman for melt growth of bulk crystals:

- Crucible rotation
- Three zones
- Temperatures up to1250°C
- Ampoule diameter up to 2"

Chemical Vapor Transport (CVT)

Two identical CVT systems are available.

- Four zones
- Temperatures up to 1100°C
- Ampoule diameter up to 2"

Support Equipment

Do all of your powder and ampoule preparation in-house.

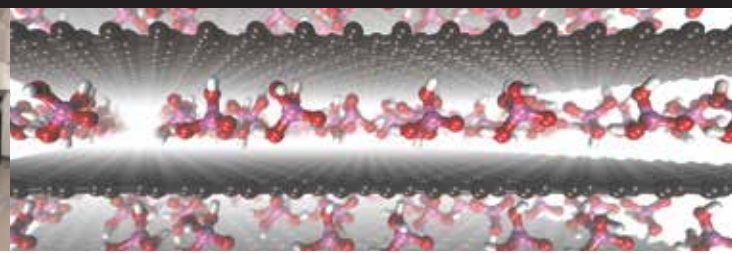
- Compounding Furnace – powder melting and mixing up to 1250°C
- Glove Box – powder preparation
- Quartz Sealing Station – up to 2" diameter
- Ampoule Loading Station – wide variety of transport agents (Br, I, and Cl)

Contact

Joan Redwing / Director, Synthesis Lead
email: jmr31@psu.edu

Tom Mallouk / Bulk Synthesis & Exfoliation
email: tem5@psu.edu

THEORY and SIMULATION



Unique Capabilities

Combined expertise of the 2DCC theory team and technical capabilities of the Materials Computation Center (MCC) and the Institute for CyberScience – Advanced Cyberinfrastructure (ICS-ACI) at Penn State.

- Overcome experimental obstacles
- Aid in interpreting *in situ* characterization and post-synthesis sample measurement
- Predict new synthesis targets

Access to MCC Software Tools

- First-principles (Quantum Espresso, VASP, etc.)
- Empirical methods capable of long time scales and length scales at both atomistic (ReaxFF) and phase-field levels

Contact

Vincent Crespi / Theory Lead
email: vhc2@psu.edu

RELATED FACILITIES

All MIP users have access to extensive related facilities for characterization and device fabrication.

Materials Characterization Lab
web: mri.psu.edu/mcl

Nanofabrication Lab
web: mri.psu.edu/nanofab

Both labs are conveniently located adjacent to MIP facilities in the Millennium Science Complex.