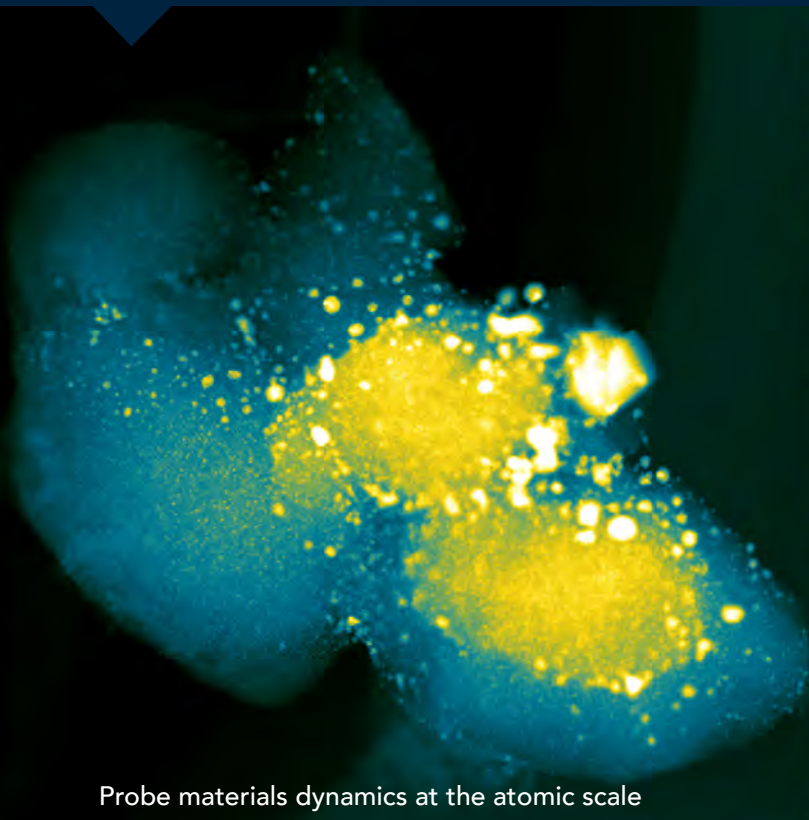
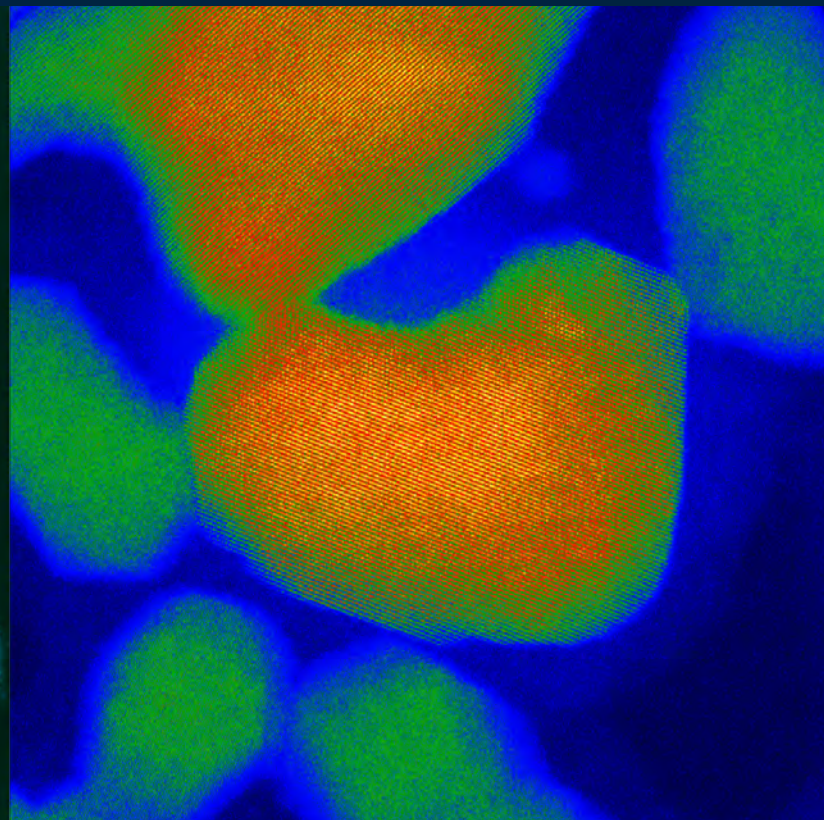


# IN-SITU/OPERANDO ELECTRON MICROSCOPY (InToEM) CENTER

INNOVATION PARTNERSHIP BUILDING AT UCONN TECH PARK



Probe materials dynamics at the atomic scale



## About

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The IN-siTu/Operando Electron Microscopy (InToEM) center represents a partnership between DENSsolutions and UConn Tech Park. DENSsolutions is a one of the world leading suppliers of state-of-the-art MEMS-based In Situ systems that bring stimuli like heating, biasing, gas and liquid into transmission electron microscopes. The InToEM center transforms transmission electron microscopes from an imaging instrument into a comprehensive research laboratory on a chip.

At the InToEM center, material scientists, chemists, physicists, computer scientists and engineers working together at the frontier of understanding materials dynamics. These new in-situ/operando microscopy capabilities and collaborations hold promising potential for transformative research in nanomaterials synthesis, heterogenous catalysis, corrosion and alloy degradation, fuel cells and many other material systems important to every day life.

## Areas of Expertise

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- Catalysis
- Nanostructure Growth
- Phase Transformation
- Redox Reaction
- Defect Motion
- Thermal Effect
- Material Degradation
- Kinetics
- Calorimetry
- Residual Gas Analysis
- Computer Vision
- Real-time Object Tracking

## Center Characteristics

### Overview

Like people, materials also go through a life cycle from synthesis, processing/activation, operation to deactivation/degradation and possible regeneration with numerous dynamic restructuring and interactions under working conditions or at different operation stages. This dynamic process requires dynamic characterization methods that probe materials systems at relevant spatial or temporal scales. However, conventional materials characterization is performed at room temperature in ultra-high vacuum.

Equipped with the state-of-the-art in-situ TEM system, at the InToEM center we are able to carry out direct real-time observations of dynamic changes in material crystal structure, morphology, composition and even electronic states under technically relevant working conditions. These new insights into materials dynamics provide invaluable understanding in the structure-property correlation, opening up new opportunities for data-informed materials optimization and engineering.

### Unique Capabilities

At the heart of the research center is the highly specialized Climate MEMS-based Nano-Reactor from DENSolutions. Our Climate system is equipped with the full Gas Supply system which offers real time and fast dynamic mixing of up to 3 gasses. Connected to the Gas Supply system is a Nano-Reactor. The Nano-Reactor is

the MEMS based device that acts as a functional sample carrier enabling the gas-heating environment within a transmission electron microscope. Operating in synergy, the in-situ system allows a defined amount of gas to be flowed through an inert Nano-Reactor chamber where the sample temperature is controlled by an integrated micro-heater and temperature sensor.

Replicating the real-world industrial chemical reactor, the Nano-Reactor allows sub-Angstrom resolution imaging in conjunction with the microscope and analysis of gas-solid reactions. The UConn scientists working in the center can monitor dynamic changes in local site-specific structural information of nanomaterials in real-time under realistic reaction conditions. This means they are able to gather more applicable information about what exactly is happening to the materials being tested, and can also conduct concurrent mass-spectrometry, calorimetry and chemical analysis while the material is in operation. In parallel, dedicated Machine Learning algorithms are under development to support high-throughput feature recognition and real-time tracking.

### Key Components of DENSolutions Partnership

- Up to date in-situ software
- Advanced training
- Data synchronization support
- Unique operation mode support



“Lab on Chip” in-situ TEM gas & heating system

## Contact

### IN-siTu/Operando Electron Microscopy (InToEM) Center

Yuanyuan Zhu, Ph.D.  
Director of InToEM  
Phone: (860) 486-2378  
Email: [yuanyuan.2.zhu@uconn.edu](mailto:yuanyuan.2.zhu@uconn.edu)

### Innovation Partnership Building (IPB)

S. Pamir Alpay, Ph.D.  
Executive Director of IPB | UConn Tech Park  
Phone: (860) 486-6917  
Email: [pamir.alpay@uconn.edu](mailto:pamir.alpay@uconn.edu)