



# MECHANICAL & MATERIAL COLLOQUIUM

## Engineering Materials at Extreme Conditions: Insights from High-Pressure Chemistry

*by Irina Chuvashova (Florida International University)*

Chemistry under extreme conditions, such as pressures exceeding 10,000 times atmospheric pressure and temperatures ranging from cryogenic to ultra-high, provides an unparalleled opportunity to synthesize materials that cannot be formed under ambient conditions. This multidisciplinary field bridges materials science, physics, and engineering with applications in energy, nuclear technologies, and environmental sciences. Addressing the critical need for multifunctional, energy-efficient, and environmentally friendly materials, this research is vital for advancing technologies in thermoelectrics, energy storage, optoelectronics, piezoelectrics, and nonlinear optics. High-pressure chemistry induces structural, electronic, and magnetic transformations in materials, facilitating the synthesis of metastable phases. Understanding these processes, particularly the structure-property relationships through in situ studies, is essential for optimizing their industrial applications. My research centers on rare-earth-containing materials and those incorporating boron and other elements, focusing on how synthetic conditions, reactant composition, and compression affect their thermal and electrical properties. My approach integrates advanced techniques, including multi-grain single-crystal X-ray crystallography and Raman spectroscopy at extreme conditions. These studies utilize diamond anvil cells, double-sided laser heating, and the Paris-Edinburgh press, enabling the detailed study of structural and electronic properties. This approach enables the development of innovative materials with transformative potential for energy and nuclear applications, advancing our understanding of how extreme conditions drive material synthesis and discovery.

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Dr. Irina Chuvashova (Shaporeva) completed her undergraduate studies in the Chemistry Department at Lomonosov Moscow State University. She earned her Ph.D. in Materials Science from the University of Bayreuth, Germany, in 2017. Before moving to the United States, she conducted postdoctoral research in Paris, France. Dr. Chuvashova has also worked at Carnegie Science in Washington, DC, and in the Physics Department at Harvard University in Cambridge, MA. Since August 2021, she has been a professor in the Chemistry Department at Florida International University, where she leads an active research group focused on high-pressure materials science at the intersection of physics and chemistry. Her group investigates the structure-property relationships of



materials under extreme conditions, with applications across various fields. Her research explores how extreme conditions impact the physical and chemical properties of materials, including their structure, phase transitions, chemical reactions, and conductivities. This work is vital for the development of multifunctional materials for energy and nuclear technologies. Dr. Chuvashova is an expert in multi-grain single crystal X-ray crystallography and Raman spectroscopy under extreme conditions, using diamond anvil cells, double-sided laser heating, and the Paris-Edinburgh press. She regularly lectures at national and international scientific conferences and has authored numerous peer-reviewed publications.

**Place:**  
**EC 1113**

**Time:**  
**2:00-3:15 PM**  
**Feb. 4, 2025**

<https://mme.fiu.edu/seminar-schedule>

For questions, comments and suggestions, contact Colloquium Organizers Dr. Benjamin Boesl ([bboesl@fiu.edu](mailto:bboesl@fiu.edu)) or Dr. Jiuhua Chen ([chenj@fiu.edu](mailto:chenj@fiu.edu))