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CONNECT Undergraduate Research Experience

Mark Messner, Ph.D.

Argonne National Laboratory

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Accelerating the qualification of new high temperature materials

The development and adoption of new materials with improved high temperature strength and thermal properties is crucial in decarbonizing carbon-intensive industries and mitigating climate change. However, the process of qualifying a new material for use in safety critical applications at high temperatures is long and expensive, often requiring decades before a new material sees industry service. This talk describes the current qualification process, focusing on high temperature structural materials used in energy generation and storage, and analyzes the current approaches to explain why qualification takes so long. The talk then surveys options for accelerating high temperature qualification, discussing options including the wider use of physics-based models, machine learning techniques, reliability-based design, and other approaches aimed at reducing the time between material discovery and when the new material sees its first applications. The discussion includes several examples drawn from work on high temperature nuclear reactors and concentrating solar power systems.

Dr. Mark C. Messner is the Group Leader of the Thermal and Structural Materials Modeling and Simulations Group in the Applied Materials Division at Argonne where he works on modeling, simulating, and designing high temperature materials and structures. His research areas include mesostructural and engineering-scale material modeling, structural and material design and optimization, development of simulation methods, and engineering design method development. He has a particular interest in the design and safe operation of high temperature nuclear reactors, concentrating solar power facilities, and thermal energy storage systems.

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