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Advancing Magnesium Alloy Development: How Design and Databases Play a Critical Role

Abstract: Modern materials contain extraordinary levels of complexity with components spanning a hierarchy of length scales. Designing materials that contain complex microstructures and demonstrate unique behaviors would be difficult solely using a reductionist approach to materials development. Although this approach has led to many technological breakthroughs, the rapid evolution of technology and the need for a shortened materials development cycle are driving materials scientists toward a more predictive approach based on design. A powerful utility in this endeavor is the use of computational thermodynamic and kinetic tools. The integration of these tools into a systems-based materials design methodology that couples experimental research with theory and mechanistic modeling has been established to accelerate materials development. Microstructural properties can be expressed as thermodynamic parameters that are predictable by computational thermodynamic tools, while kinetic simulations can assist in elucidating processing-structure relationships to quantify microstructural evolution. Experimental prototypes are then created to experimentally analyze and validate the design models that feed back into the working design for optimizing materials performance while minimizing design iterations. A roadmap for materials design and its relationship to computational thermodynamics and kinetics will be discussed in its application to structural materials where active mechanisms are complex and interacting. This talk focuses on the high temperature magnesium alloy development as a model system. It will be shown that strategically pairing experimental and computational methodologies will minimize the need for large-scale experiments while simultaneously promoting the rapid development of materials.

Biography

Michele Manuel is the Department Chair of the Department of Materials Science and Engineering at the University of Florida. She received her PhD in Materials Science and Engineering at Northwestern University in 2007 and her BS in Materials Science and Engineering at the University of Florida. She is and ASM Fellow and the recipient of the Presidential Early Career Award for Scientists and Engineers (PECASE), NSF CAREER, NASA Early Career Faculty, ASM Bradley Stoughton Award for Young Teachers, AVS Recognition for Excellence in Leadership, TMS Early Career Faculty, TMS Young Leaders Professional Development, and TMS/JIM International Scholar Awards. Her research lies in the basic understanding of the relationship between processing, structure, properties and performance. She uses a systems-based materials design approach that couples experimental research with theory and mechanistic modeling for the accelerated development of materials. Her current research is focused on the use of systems-level design methods to advance the development of new materials through microstructure optimization. Of specific interest are lightweight alloys, self-healing metals, computational thermodynamics and kinetics, shape memory alloys, and materials in extreme environments – specifically under high magnetic fields or under irradiation.