Computing@PNNL SEMINAR

Integrated Computational and Experimental Materials Engineering (ICEME) for Vehicle Lightweighting

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Computational materials engineering (CME) tools capable of integrating microstructure-based material and process design with performance-driven structural optimization can significantly enhance manufacturing competitiveness. Thus, the automotive industry is embracing ICEME tools in pursuit of aggressive engineering strategies that meet impending fuel economy and vehicle mass targets in a sustainable manner. CME tools can aid the smart use of current materials and accelerate development of light metals with enhanced formability and crashworthiness. Successful ICEME application requires combining experiments with computation at various length scales, for both calibration and validation of the numerical models. Dr. Mishra's talk will present multiscale computational frameworks involving coupled micro- and macro-scale numerical models for high strength aluminum alloys, advanced high strength steels (AHSS), and magnesium alloys. For microscale computations, a new three-dimensional (3D) finite element analysis based on rate-dependent crystal plasticity theory incorporates 3D microstructures accurately constructed from 2D electron backscatter diffraction data. Meanwhile, the macroscale computations are done with advanced yield functions informed by microscale models. The so-called *Extended Finite Element Models* and *Element Free Galerkin* approaches are used. Coupling these models with optimization frameworks based on genetic algorithms and neural networks provides a comprehensive ICEME toolset to satisfy design and performance requirements with materials and processes while also meeting cost, mass, and performance needs. An illustration of this integrated approach for a component-level application also will be presented.

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