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Identification of fatigue precursors via quantitative nondestructive evaluation

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ABSTRACT

Understanding evolving fatigue microstructure–properties–behavior relations is both challenging and needed in view of the time and length scales involved at both coupon and component levels. To reliably formulate quantitative descriptions of remaining useful life for advanced materials recent developments reported in the Integrated Computational Materials Engineering framework including in situ/ex situ experimental observations and high-performance simulations, continuously provide valuable insights. This discussion focuses on describing the role quantitative nondestructive evaluation (NDE) can play in this multidisciplinary effort to identify fundamental mechanisms that dominate fatigue life by presenting results obtained from a range of materials including polycrystalline alloys and fiber-reinforced composites. Emphasis is given on using multimodal NDE data to first identify intervals in time and regions at several length scales in which fatigue damage precursors could be found. Results from targeted observations of the evolution of such precursors are then used to formulate hypotheses on the fatigue behavior which are implemented in analytical and computational models. Challenges and future opportunities created by adopting this type of approach are also discussed.