The Role of Strain Localization at Interfaces on Fatigue Crack Initiation in Highly Textured Magnesium Alloys

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New and novel materials with extraordinary properties, from superior fatigue resistance to excellent high temperature performance, enable a shift from energy-expensive materials to sustainable materials with a positive impact on communities and the environment. Though these material systems provide many advantages, the underlying meso- and micro-scale structures are complex and as a result, the mechanical behavior is very different than that of traditional metallic alloys. Of the properties, fatigue – the repeated cycling of stress on a material – is the most critical form of damage in load bearing structures. In fact, fatigue accounts for 80 to 90% of failures in structural components and is still a major problem in many industries. Though fatigue has been studied for over 180 years there are still gaps in our understanding of the processes controlling fatigue crack initiation and growth. This project will directly address these challenges using a specifically designed and multimodal systematic study that combines electron microscopy, digital image correlation, and high energy X-ray based techniques to understand the mechanisms of damage accumulation at interfaces in complex microstructures leading to crack initiation and growth. A fundamental understanding of the complex interactions at the meso- and micro scale that influence fatigue behavior and crack initiation will provide the underpinning knowledge needed to: 1). inform physically based models that accurately predict fatigue lifetime in complex systems and 2). develop fatigue resistant, microstructurally, and compositionally complex alloy systems.

This research was selected for funding by the Office of Basic Energy Sciences.
