The Summer Undergraduate Research Fellowship (SURF) Symposium
3 August 2017
Purdue University, West Lafayette, Indiana, USA

Using high resolution images to investigate fatigue crack initiation of alloys at the microstructural level.

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ABSTRACT

Microstructural features within a material dictate the material's mechanical behavior and lead to localized strains as the sample is deformed. In order to further understand structural failure, an improved understanding of how microstructural features influence failure is necessary. Fatigue crack initiation is one common mode of failure for aerospace applications, and a better understanding as to how fatigue cracks form can lead to increased longevity of aerospace systems. This paper investigates the idea that fatigue crack initiation for a cyclically loaded sample is correlated to areas of higher localized strain. First, a titanium nanopowder solution is applied to an area of interest. The titanium particles on the sample are then imaged in an optical microscope, and the displacement of each particle is measured after loading the sample. The resultant displacement field is converted into a strain field, which will indicate locations on the sample with higher localized strains. When comparing sites of crack initiation to the strain field map, there is a tendency for cracks to initiate near locations with high localized strains. This knowledge can lead to an improved ability to predict fatigue crack initiation locations, and can also be used to improve structural designs at the microstructural level.

KEYWORDS

Microstructure, strain localization, fatigue, Digital Image Correlation, Electron Backscatter Diffraction