The Summer Undergraduate Research Fellowship (SURF) Symposium
4 August 2016
Purdue University, West Lafayette, Indiana, USA

Evaluation of Strain Distortion Correction Protocol using Scanning Electron Microscopy and Digital Image Correlation

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ABSTRACT

Scanning electron microscopy in combination with digital image correlation (SEM-DIC) is a useful technique for measuring strain in materials at the micro-scale. In particular, it can be used to identify micro-scale strain localizations that are the precursor to material failure. While SEM produces high resolution images of the microstructure, the images also contain a large amount of distortion that, during DIC, will result in distorted strain values that require correction. In this project, a nickel-based alloy underwent cyclic mechanical fatigue at three different high temperatures to a targeted maximum strain. Scanning electron microscopy imaging was done on a 200x150μm area sectioned into nine of the specimen before and after testing for digital image correlation, and electron backscatter diffraction (EBSD) was also used to image the grain boundaries within the sample area. Digital image correlation was done using the software Vic-2D, and corrections were done by following the protocol previously developed. The images were then stitched together and the EBSD images were overlaid the strain maps in MATLAB™. Results show that with the use of this protocol, corrected strain measurements are approximately equal to the macroscopic strain values obtained from testing, but allows for spatial strain fields relative to the microstructure. The accuracy with which this protocol is able to correct strain bias due to SEM makes it a useful tool for measuring strain value for this material, and can be used to estimate the strain values at which strain localization begin.

KEYWORDS

Microstructure, scanning electron microscopy, digital image correlation