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PROBABILISTIC MODELING OF LCF FAILURE TIMES USING A EPIDEMIOLOGICAL CRACK PERCOLATION MODEL

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The analysis of standardized LCF experiments shows that the failure times widely scatter. Furthermore mechanical components often fail before the deterministic failure time is reached. A possibility to overcome these problems is to consider probabilistic failure times.

Our approach for probabilistic life prediction is based on the microstructure of the metal. Since we focus on nickel-base alloys we consider a coarse grained microstructure, with random oriented FCC grains. This leads to random distributed Schmid factors and different anisotropic stress in each grain. To gain crack initiation times we use Coffin-Manson-Basquin and Ramberg-Osgood equation on stresses corrected with probabilistic Schmid factors.

Using these single grain crack initiation times, we have developed an epidemiological crack growth model over multiple grains. In this mesoscopic crack percolation model, cracked grains induce a stress increase in neighboring grains. This stress increase is realized using a machine learning model trained on data generated from finite element simulations. The resulting crack clusters are evaluated with a failure criterion based on a multi modal stress intensity factor. From the generated failure times, we calculate surface dependent hazard rates using a Monte Carlo framework.

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