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CHARACTERIZING THE FATIGUE BEHAVIOR OF WROUGHT FE-CO-2V USING EXPERIMENTAL, COMPUTATIONAL, AND ANALYTICAL TECHNIQUES

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Fe-Co-2V is a soft, ferromagnetic material that is commonly used for electrical components that require strong magnetic properties. Applications include high-performance transducers, actuators, high field magnets, and solenoid valves. Despite the excellent magnetic properties of Fe-Co-2V, it often exhibits low strength, poor ductility, and low workability due to a phase transformation from disordered BCC to an order B2 microstructure. Current and emerging applications for Fe-Co-2V require a thorough understanding of its fatigue performance; however, limited fatigue data currently exists for Fe-Co intermetallic alloys. Therefore, this work characterizes the fatigue properties of wrought Fe-Co-2V through strain-controlled fatigue testing coupled with numerical and analytical modeling. Young's Modulus, ultimate strength, and yield stress were determined through monotonic tension tests. The fatigue behavior was characterized using fully reversed, strain-controlled fatigue testing for applied strain amplitudes ranging from 0.1% to 1.0%. Failure mechanisms were subsequently investigated through fractography with a scanning electron microscope. Inspection of the failure surfaces revealed that crack initiation occurred at defects at or near the specimen surface with propagation of less than approximately 200 microns before final brittle fracture. A combined numerical and analytical approach was taken for developing a predictive fatigue failure model. A microstructure-sensitive multistage fatigue (MSF) model was used to predict total cycles until failure and provided upper and lower bounds on fatigue life based on initial flaw size. Parameters obtained from micromechanical finite element simulations, such as maximum plastic shear strain range and crack tip opening displacements, were used as inputs to the MSF model.

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