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Effect of surface mechanical attrition treatment on low cycle fatigue properties of an austenitic stainless steel

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Abstract

In order to study the influence of surface mechanical attrition treatment (SMAT) on low cycle fatigue (LCF) properties of an austenitic stainless steel AISI 316L, cyclic loading responses and fatigue lifetime are investigated using fully reversed tension-compression LCF tests under total strain control. The results reveal that SMATed material exhibits higher cyclic stress amplitude due to higher strength of the SMAT affected region. During cyclic loading, untreated material is hardened under high strain amplitude (±0.8%, ±1.25%), but softened under low strain amplitude (±0.5%). In contrast, SMAT affected region undergoes cyclic softening. Furthermore, SMAT mainly affects cyclic behavior of the early stage of LCF, and its effect is gradually reduced as cyclic loading goes on. Fatigue lifetime analysis indicates that SMAT could decrease the fatigue lifetime of material under cyclic loading with high strain amplitude (±1.25%). Based on analysis using Coffin-Manson law and energy dissipation theory, this lifetime decrease is considered to be due to the decrease of ductility and fatigue damage capacity.

Keywords: SMAT, Nanocrystalline materials, Low cycle fatigue, Material characterization, Stainless steel