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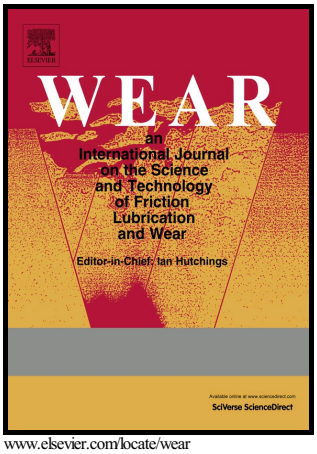

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Study on the damage evolution of torsional fretting fatigue in a 7075 aluminum alloy

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Abstract：A torsional fretting test of 7075 aluminum alloy is carried out on a fretting fatigue test rig, which is independently designed based on a multi-axis fatigue testing machine, and thus the *S-N* curve for this material is established. The damage regions of torsional fretting fatigue are analyzed with 3-D profilometer, Scanning Electron Microscopy and Electron Probe Microanalyzer. The results reveal the damage mechanism of the torsional fretting fatigue on different regimes, and the fatigue life is greatly reduced due to the fretting acting. The *S-N* curve of the torsional fretting fatigue presents characteristics of a *Z*-shaped curve. The coefficient of friction increases with the torque, while when the fretting is running in the mixed fretting and slipping regimes, oxidation of the damage regions near the loading end becomes severe, accompanying with micro-cracks; while in the partial slipping regime, the oxidation is mild without micro-cracks.

Key words: 7075 aluminum alloy; torsional fretting fatigue; damage mechanism; micro-crack

1. Introduction

Fretting fatigue (FF) means an event that the fastened mating contact surfaces move relatively in the micron, and such random or cyclic movements induce wear of the contacted surfaces. Under specific conditions, fretting cracks may be triggered. Generally, FF accelerates the initiation and propagation of micro-cracks, resulting in premature failure of the component [1-3]. In fact, the FF widely exists in aerospace and automotive components, civilian machineries, railways, electrical appliances, nuclear reactors, bridges, and biomedical and other parts [4-7]. Typical examples include axles of high-speed trains, motor shafts and turbine blades of aircraft engines. It significantly reduces the service lifetime of these parts in various fields. Researchers mainly investigate in tension-compression FF [8-10] and bending fretting fatigue (BFF) [11-13], while the torsional fretting fatigue (TFF) is rarely investigated [14,15]. Juuma studied the relationship between the TFF life and the contact stress, slip amplitude, and geometry of the shaft [14, 15]; however, the