Abstract

Most of the aero-engine components and structures are subjected to life critical fatigue loads during service. In the compressor module of aero-engines, titanium alloys are used due to their superior fatigue resistance and specific strength. Near-α titanium alloy IMI 834 is one of the candidate titanium alloys for the compressor application. The microstructure of IMI 834 alloy typically contains α and β phases. It has been reported that different heat treatment conditions affects the morphology, topology and dimensions of different phases present in the alloy which results in improvement in various properties. In this present study, the effect of a typical heat treatment on high cycle fatigue has been investigated in a near-α titanium alloy IMI 834. The alloy was solution heat treated at a temperature of 1060°C with subsequent quenching in different cooling media with varying cooling rates (Furnace Cooled (FC), Air Cooled (AC), Oil Quenched (OQ), Water Quenched (WQ)). Samples were extracted from each condition. These samples were later tested for room temperature fatigue loading under varying stress amplitudes. A strong effect of quenching media and cooling rate on HCF life has been observed for this alloy. Standard S-N curves as per ASTM E-466 were obtained for each condition (FC, AC, OQ, WQ). The generalized stress life model ($\frac{\Delta\sigma}{2} = \sigma_f^{'}(2N_f)^b$) has been deduced from the fatigue data. Further, this stress life model was integrated with finite element analysis to develop a fatigue model for near α titanium alloy IMI 834 under the typical heat treatment condition. This fatigue model can be further extended to perform fatigue life analysis of aero-engine components. Fractography were also investigated to observe the micro-mechanism of high cycle fatigue in the present alloy.

Keywords : IMI 834, HCF, heat treatment, stress-life model.