Abstract

In critical applications of power plants, the processing to which materials were subjected and the evolving microstructures of hot gas path components play a pivotal role in controlling the deformation behaviour and life. Understanding the microstructural issues on life is, therefore, a pre-requisite for optimizing the heattreatment conditions. Haynes 282 is a modified version of an advanced ultra super critical alloy. The microstructure of Haynes 282 comprises a γ-γ' microstructure and is required to meet the qualities of a candidate material for turbine rotor parts. In this regard Haynes 282 has been investigated to develop an understanding of cyclic deformation behavior i.e for low cycle fatigue, creep-fatigue interaction in context to the microstructural evolution. To achieve sufficient understanding of the microstructural evolution, a series of cooling rate experiments have been done in order to study the evolution of precipitate size, internal stress and coherency strain by diffraction methods, and spectroscopic methods like EELS which has also been employed. Two microstructural extremes have been generated by slow and fast cooling and these microstructures were subjected to monotonic deformation like tensile, creep and HTLCF. An increase in stage II hardening for coarser precipitates; negative creep and high anisotropy for air cooled finer precipitates have been observed. A novel ultrasound-based probing methodology was also an outcome of this study which accurately measures the crack density. Creep-fatigue interaction is the main damaging mechanism for power plants and the influence of waveform has been studied. Variable strain rate low cycle fatigue tests i.e. applications of different strain rates in different portions of a cycle (VSRLCF), non-peak dwell and non-peak dwell accompanied by peak dwell (NP and P-NP both with hold time of 1000 seconds) and standard peak dwell for 1000 seconds are imparted and it has been seen that the non-peak holds are less damaging. The life and damage have also been evaluated in this regard. A new way of performing simultaneous creep-fatigue tests, by applying stress controlled hold superimposed in a strain controlled waveform has been attempted and analyzed. Lastly, a lifing methodology to rank the microstructures in accordance with its creep fatigue interaction has been formulated based on relative accumulation rate of creep and fatigue strain.