MEASURING CRACK INITIATION AND THE PLASTIC DEFORMATION BEHAVIOUR OF TITANIUM ALUMINIDES UNDER COMPRESSIVE AND TENSILE UNIAXIAL LOADING

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At temperatures of the order of 700 °C, suitable for the operation of low and intermediate pressure turbines and compressors in gas turbine engines, gamma titanium aluminides possess a higher specific strength than nickel superalloys. However, γ-TiAl suffers from a sufficiently reduced plasticity for a threshold approach to fatigue lifing to be necessary. Improving the fatigue behaviour of γ-TiAl requires an understanding of crack nucleation and how this is related to the detailed microstructure.

Towards this, the monotonic compressive and tensile deformation behaviour of this two-phase lamellar composite alloy, Ti-45Al-2Nb-2Mn(at.%)-0.8vol%TiB_2, currently undergoing engine tests by Rolls Royce, has therefore been measured at both room temperature and at 700°C. Both colony and lamellar-scale deformation features of the material have been investigated. Microstructural conditions with varying lamellar thicknesses were characterised by scanning electron microscopy and transmission Kikuchi diffraction. The near-surface plastic strain field and the build-up of local strains have been measured, using digital image correlation, with a remodelled gold speckle pattern, and compared with misorientation mapping using electron backscatter diffraction, both before and after testing.

Temperature was found to have a significant impact on the active deformation mechanisms and their directions relative to the lamellae; this affects the ability of the material to provide compatible deformation. At high temperature, the shear generated upon twinning was found to be closely associated to debonding at colony boundaries. This is related to the possible accumulation of damage in cyclic loading.