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Dwell fatigue crack propagation behaviour and the influence of crack oxidation measured by micro cantilever of nickel-base superalloy ATI 718Plus

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Abstract

The understanding of the crack propagation behaviour and the interaction of the crack with high temperature phases, such as the δ- and the η-Phase in 718Plus, is of key importance for the development, optimisation and application of modern polycrystalline Ni-base superalloys. It has been shown that the orientation of η/δ plate-like precipitates have a major influence on high temperature dwell fatigue crack propagation in air. If the precipitates are orientated parallel to the crack propagation direction, the crack resistance is reduced [1]. By micro cantilever testing, the interaction of the crack with the η/δ precipitates and the oxidation of the phase boundaries and the crack surfaces as well as the effect of the formed oxides on the crack propagation is studied. It is shown that the crack propagates along the η/δ-matrix interface by oxidizing the η/δ-matrix interface ahead of the crack tip. An Nb-rich oxide layer forms due to the Nb present in the η/δ phase. Where no η/δ plate precipitates are adjacent, a Cr and/or Ni rich oxide layer is formed. Micro cantilever testing on the oxidized interface shows that these oxide layers drastically reduce the local strength and fracture toughness of the material. This proves that Nb-rich oxide layers have negative effect on the dwell fatigue crack growth resistance.

Keywords: A718Plus, Dwell fatigue crack oxidation, η/δ-Phase, micro cantilever

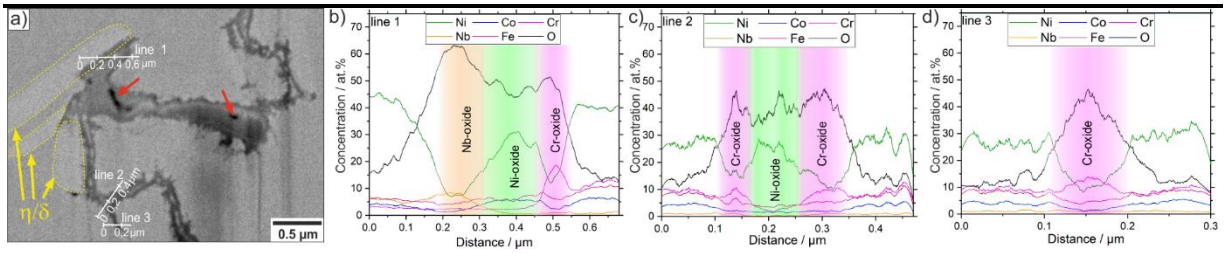

Figure 1: Three different EDS linescans at an oxidized crack measured in a TEM foil.

Reference:

[1] D. Huenert et al., ATI718Plus® - New Nickel Based Disc Alloy and its Capability, Superalloys 2016, 2016, 781–792.