ICSMA19 Metz, France, June 26 - July 1, 2022
International Conference on Strength of Materials

Fatigue Strength Behavior and Creep Fatigue Interaction in the Bimodal $L1_2$ (γ') Strengthened Nickel-Based Alloy 718Plus

Barun. B. Dash[a,b*], M. Sundararaman[a], R. Brandt[b], H. -J Christ[b], S. Sankaran[a]

[a]*Department of Metallurgical and Materials Engineering, Indian Institute of Technology Madras, Chennai, India*

[b]*Department of Mechanical Engineering, University of Siegen, Siegen, Germany*

[a]*barun.dash@gmail.com*

718Plus, a $L1_2$ ordered gamma prime (γ') strengthened alloy, owing to its high thermal stability, a combination of good formability and weldability, may serve as a viable replacement of commercial superalloy in turbine disk applications. [1]. Continuous exposure to cyclic loading makes material fatigue the major mode of failure. A change in the particle size and distribution can improve the mechanical behaviour. To understand the role of modified gamma prime (γ') distribution, particle size and their effect on damage mechanisms, which are often introduced by dislocation precipitate interaction through particle shearing, are being studied through low cycle fatigue (LCF) and creep fatigue interaction (CFI). A bimodal distribution of γ' precipitates was generated from a solutionized alloy by subjecting it to a two-step aging treatment of 905°C and 710°C. The grain size was 116 μm. The average size of large γ' particles were 63 nm and the fine γ' particles 8 nm (approx.). The standard unimodal sample was generated from a solutionized alloy with a two-step ageing at 785°C and 704°C (8hr)/ AC (air cooling) with a final grain size of 46 μm. The average γ' particle size was 73 nm. The mechanical properties of both the alloys were studied by conducting tensile and compression tests at room temperature and at 650°C. The unimodal samples depicted slightly better mechanical responses in comparison to the bimodal samples, owing to finer grain size and presence of delta precipitates at grain boundaries for additional strengthening. LCF tests were conducted at room temperature and at 650°C under plastic strain control mode. LCF tests also included experiments carried out under vacuum at 650°C to understand the effect of environment on fatigue life. CFI experiments were conducted under compression with variable dwell times under peak compression load only. TEM was employed to investigate the evolution of γ' precipitates and also the dislocation-precipitate interaction mechanisms. The results are rationalised on the basis of present understanding of precipitate dislocation interactions.

Keywords: Low Cycle Fatigue, Creep Fatigue Interaction, 718Plus, Superalloy

References:

[1] Kennedy, R. L. (2005). Allvac® 718plusTM, superalloy for the next forty years. In Proceedings of the International Symposium on Superalloys and Various Derivatives (pp. 1–14). Minerals, Metals and Materials Society