

NICKEL-BASED SUPERALLOY, RELATION BETWEEN NON-LINEAR ULTRASOUND AND MICROSTRUCTURE CHANGES DUE TO CREEP DAMAGES

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Nickel-based superalloy, Inconel[®] 718, has high temperature strength effected by γ'' (Ni₃Nb) phase at approximately 973 [K]. Inconel 718 was determined that the γ'' phase disappearance lead to the creep destruction. In the study, we applied the nonlinear ultrasonic method for evaluation the creep damages and the microstructural degradation in γ'' phase for Inconel 718 test pieces at the evaluated temperature 973 [k]. The nonlinear ultrasonic shows the possibility to becoming the primary means of characterizing creep in the metals [1, 2], because it is to probe the change of dislocation structure during the creep. Its sensitivity to microstructural evolutions during the creep is often higher than that of linear properties. We analyzed the relation between the microstructural change and the propagation of nonlinear acoustic characterizations three-wave interacting [3], with the electromagnetic acoustic resonance (EMAR) [4] throughout the creep life, and nonlinearly relations change in dislocation density. This was supported with X-ray diffraction, EBSD [5] and SEM images.

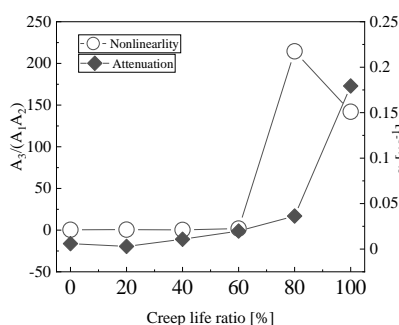


Fig.1. Propagation of attenuation coefficient α_r and the nonlinearity with three-wave interaction at the creep life. (1,253[k], 200[MPa])

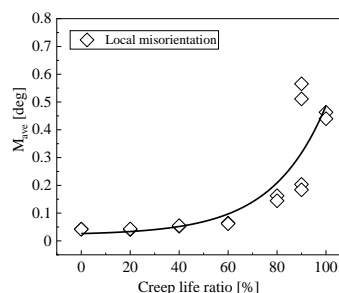


Fig.2. Miss-orientation average analysis by EBSD

Fig.1 shows the propagation of the nonlinearity in three-wave-interaction, ultrasonic attenuation, α ; nonlinearity rise dramatically and rapidly from 60[%] of the creep life ratio. After the peak, the nonlinearity decrease near the rupture. Propagations of α shows the gradually increase of the 60 [%] of creep life. α increases sharply until the rupture. Fig.2 shows EBSD measurement of local miss-orientation average (M_L). M_L show the increases rapidly from 60[%] of the creep life.

This phenomenon shows nonlinearity, and α , M_L as creep progress related to the microstructure changes, especially, to the dislocation mobility during the creep life.

SEM images shows δ phase appearance at 60[%] of the creep life. This phenomenon is Coarsening of γ'' phase during the creep damages.

Assessment of the advanced creep damage and microstructural changes of the metals may potentially facilitate by the nonlinear acoustics measurement with EMAR. In future, we may have any prospect due to Energy Reflection.

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