Interior micro-defect induced cracking mechanism and life prediction of carburized Cr-Ni steel based double nonlinear damage under variable amplitude loading

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Abstract

The variable amplitude loading fatigue test with interior Inclusion-FGA-Fisheye induced failure under $R = 0$ was carried out on carburized 12CrNi₃ steel in very high-cycle fatigue regime. Comparing with $S-N$ curve of constant amplitude loading, the total life is inevitably longer under variable amplitude loading. And, the surface morphology of FGA is coarser under same order of magnitude of fatigue life. Simultaneously, it can be determined that the formation micro-mechanism of FGA is caused by the continuous debondings of refined grains due to stress concentration around interior micro-defects, and variable amplitude loading will aggravate the formation of FGA. Furthermore, the life prediction model based on double nonlinear fatigue damage, which considers the coupling effect of local equivalent stress (surface residual stress, maximum stress and local stress concentration by RVE model), loading sequence and failure mechanism is established, and predicted life has good accuracy within the factor-of-three lines for experimental life.

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