Damage-failure transition in aluminum AlMg6 alloy under consecutive dynamic and very high cycle fatigue loads

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Consecutive dynamic and very high cycle fatigue tests are conducted to verify wide-range constituve models to predict fatigue life-time in operating conditions of gas turbine engines in accidental collisions of blades with solid particles (“foreign object damage” problem). Original approach is developed to describe damage-failure transition stages on the basis of multiscale continuum models reflecting the “criticality” of nonlinear damage kinetics. Experimental study of consecutive dynamic and VHCF loads was carried out using plate impact recovery technique providing shocked billets processing for following machining of specimens for VHCF tests. It is shown that the fatigue strength of AlMg6 alloy specimens pre-loaded by shock in the 10^9 cycle regime reduces by 24%. Fatigue damage-failure transition and crack initiation were studied by amplitude-frequency analysis of higher harmonics associated with the influence of defects on effective elastic properties. Structural study of fracture surface after consecutive loading was conducted using the profilometry data to identify the roughness scale invariants induced by defects for corresponding areas responsible for the staging of fatigue damage-failure transition. The scale invariants and corresponding lengths were used for formulation of generalized Paris law for crack advance in damaged material.

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