Modeling of the Dynamics of the Nucleation and Growth of Cracks Initiated Due to Stress in Materials

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ABSTRACT

A generalized mathematical model relating the process parameters (viz. the applied stress, defect structure and the density of the defects produced) and the process time was developed. This model is expected to predict the probability of local failure of the material under applied stress during deformation process.

The present model was successfully applied to estimate the probability of failure of nickel aluminum bronze surface layers during corrosion in ammonia and seawater, and the simultaneous application of applied stress.

The present results suggest that the corrosion induced defects increase with an increase in corrosion time and also the applied external stress. At stress levels below 15 ksi, the extent of damage is not significant compared to the corrosion under stress above 25 ksi. At high stress levels, the kappa phase and other precipitate particles in the NAB matrix are removed at much faster rate and the orientation of the crater is in the direction parallel to tension direction. The continued corrosion of NAB under high stress tends to coalesce the craters and form ridges. The orientation of these micro-cracks/ ridges is in the direction parallel to the tensile axis.

At the maximum stress level investigated here (stress ~ 45 ksi), the micro-cracks/ridges coalesce and produce large cracks. However, the orientation of these large cracks is in the direction perpendicular to the axis under tension.