Applications of Orientation Imaging Analysis to Microstructural Control of Intergranular Stress Corrosion Cracking

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Abstract

Arguably, there is no more serious materials engineering problem than intergranular stress corrosion cracking(ISCC). Considerable evidence now exists to support the view that various aspects of grain boundary(GB) geometry, its distribution and spatial placement can be altered by processing to achieve beneficial reductions in ISCC susceptibility in some alloy systems. Orientation Imaging Microscopy(OIM) provides an important new tool to rapidly and quantitatively reveal those aspects of grain boundary geometry in polycrystalline materials that may be relevant to ISCC. Applications of the method of orientation imaging are briefly reviewed, with an emphasis on measuring the distribution of interface geometry.

A new probabilistic model for crack propagation through a grain boundary network is proposed. The process of crack advance across grain boundary segments is modeled by a Markov chain. By assigning strengths to the grain boundaries, the transition probability of a crack proceeding from one grain boundary segment to another is calculated. From this information, both time-dependent crack growth and the complete path of a crack in a failed material may be described. The dependence of the crack path upon the distribution of grain boundary geometry can be estimated. This model can be used to examine ISCC in nickel-chromium-iron alloys, where the GB information will be experimentally determined using OIM.