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Neutron Diffraction Residual Stress Analysis during Fatigue Crack Growth Retardation of Stainless Steel

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Abstract

After tensile overloading during fatigue crack growth, retardation of the crack growth rate was significant. Neutron diffraction was employed to examine the evolution of crack-tip residual stress fields during constant-amplitude cyclic loading and during fatigue crack growth following the overload. It was found that the tensile overload induces larger compressive residual stress and zone size near the crack tip in the crack-growth and crack-opening direction. For the maximum crack growth retardation, the largest compressive residual stresses were measured in the region between an overloading point and the current propagating crack tip, for all three of the orthogonal directions. Such large compressive residual stresses in the crack-wake region are thought to reduce the crack tip driving force, thereby retarding the crack propagation rate significantly. Residual stress mapping was performed to examine the effect of the fatigue stress state on the residual stresses in the three different regions from the centerline to the surface, along the through-thickness direction in the compact-tension specimen. Much larger compressive residual stresses were measured at the surface than at mid-thickness. It is thought that larger compressive residual stresses at the

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