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Resistance to mechanically small fatigue crack growth in ultrafine grained interstitial-free steel fabricated by accumulative roll-bonding

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Abstract

Effects of ultrafine grain refinement on fatigue crack growth were investigated using an interstitial-free (IF) steel with a grain size of 590 nm produced by accumulative roll bonding. The fatigue properties and associated microstructures were characterized by fully reversed bending fatigue tests, replica method coupled with optical microscopy, and electron backscattering diffraction measurements near the fracture surfaces. Compared with a coarse-grained IF steel tested at the same stress amplitude, the fatigue strength of ultrafine-grained steel was higher, which was attributed to an increase in hardness. Compared with the coarse-grained steel at the same ratio of stress amplitude to hardness, the crack growth rates in the ultrafine grained steel were higher in the short-crack regime because of the smaller crack roughness and perhaps the difference in the strain gradient at the crack tip.

Keywords: crack closure; crack shape; small crack; accumulative roll bonding; ultrafine-grained steel

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