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Effect of Ferritic-Austenitic Phase Fraction on Corrosion Fatigue Behavior in Stainless Steels

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Although stainless steels are generally used in aggressive environments, the corrosion resistance is different in each stainless steel,which would be affected by microstructure. On the other hand, the initiation and early growth of fatigue cracks are also influenced by microstructure. Based on such a viewpoint, in the present study, fatigue crack initiation and growth behavior of stainless steels with different volume fraction of ferritic (α) -austenitic (γ) phases were studied in 3 %NaCl solution.

Specimens with five different volume fractions of ferritic-austenitic phases, i.e. SUS304 (100 % γ), SUS329J4L (50 % γ, 28 % γ, 12 % γ) and SUS444 (100 % α), were prepared. After heat treatments, specimens were machined. Plate specimens were employed for small cracks (L-direction), which have a shallow notch to restrict the crack initiation site, and CT-Specimens (L-Tdirection) with 8~1 0mm thickness were used for long cracks. Fatigue tests were conducted on electro-hydraulic testing machines operating at a frequency of 10~20 Hz in laboratory air and 1~3 Hz in 3% NaCl solution. Stress ratio was −1 for small cracks and 0.05 for long cracks. Crack length was measured using optical traveling microscope and replication technique for long cracks and small cracks, respectively. Crack closure for long cracks was measured by unloading elastic compliance method. Fracture surfaces were examined using a scanning electron microscope (SEM).

Cracks were generated predominantly from slip bands within γ grains for SUS304 and SUS329J4L, and within α grains for SUS444 in both environments. Both fatigue lives and fatigue limits in 3 %NaCl solution slightly decreased in all the materials compared to those in laboratory air. In early crack growth region, the crack growth rates solution were faster in 3 %NaCl than in laboratory air. Environmental effect was also found in high ΔK region for long cracks, where crack growth was enhanced in 3 %NaCl solution. Based on these results, relationships among crack growth rate, acceleration ratio and volume fraction of α/γ phase were discussed.

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