Effect of low-temperature surface hardening by carburization on the fatigue behavior of AISI 316L austenitic stainless steel

The influence of low-temperature gaseous carburization on the fatigue behavior of AISI 316L austenitic stainless steel was investigated. Tension-compression axial fatigue tests were performed under ambient conditions on untreated and carburized AISI 316L. The results show that the carburized AISI 316L has a 22% higher endurance limit compared to untreated AISI 316L. Fractography investigations with scanning electron microscope (SEM) reveal that for the untreated AISI 316L fatigue cracks initiate at the surface regardless of the applied stress level. For the carburized AISI 316L fatigue cracks initiate at the surface for relatively high-level stresses; for relatively low-level stresses fatigue cracks initiate at inclusions beyond the carburized case. After carburization, the ductility in the outmost 10μm of the carburized case has significantly reduced, leading to micro-crack occurrence during fatigue tests and associated relaxation of compressive residual stress in this region. Beyond this surface-adjacent region, no evident stress relaxation occurs due to the enhanced yield strength of the carburized case. The enhanced fatigue performance is mainly ascribed to the compressive residual compressive stress profile introduced by the carbon-concentration profile over the case. Moreover, solid solution strengthening by interstitially dissolved carbon contributes to improve the fatigue performance.

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