MICROSCOPIC LOAD-SHARING IN A DUPLEX STAINLESS STEEL AND THE INFLUENCE OF PHASE PROPERTIES

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Duplex stainless steels (DSSs) constitute an important stainless steel group which has found increasing use in recent years in engineering structures exposed to aggressive environment. The typical properties of DSSs, which combine high strength and good resistance to corrosion, are derived from a microstructure consisting of comparable amount of austenite and ferrite. In general, the ferrite is considered to be the strong phase that provides the high strength to a duplex stainless steel. Nevertheless, the macroscopic behavior of the steel under external loading also depends on the mechanical properties of the austenite and interactions between the two phases. Because of their different elastic and plastic properties, the applied stress is unavoidably distributed unevenly between the two phases. As the microscopic load-sharing has a direct influence on the mechanical properties of the steels, understanding the interactions between the applied load and microstructure and the influence of structural factors is important for the application of duplex stainless steels in engineering structures.

In the current work, we focus on studying the influence of the relative phase properties of austenite and ferrite on the microscopic load-sharing for superduplex stainless steel SAF 2507. Hot rolled bars with 43 vol.% ferrite and 57 vol.% austenite were received in solution treated and water quenched condition. To vary the property ratio of austenite to ferrite, the bars were further processed by 8% stretching or aging at 470 ^{o}C for 4 hours, respectively. After the processing, while in the deformed steel the austenite has higher strength than the ferrite, the ferrite is much harder than the austenite in the aged steel. Flat specimens were then milled from the bars and polished for use in X-diffraction experiments under in-situ tensile loading. Using the $\sin^2\psi$-method as well as the ferrite-211 and austenite-220 reflections, the evolution of phase-specific stresses with applied load was studied for three loading-unloading cycles, with the applied peak stress larger than the yielding point of the steels. In the paper, the observed different microscopic behaviors between the deformed and annealed steels are presented and analyzed with regards to the relative phase properties and initial residual stresses.