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Damage mechanism in austenitic steel during high temperature cyclic loading with dwells

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ABSTRACT

Austenitic stainless Sanicro 25 steel has been subjected to high temperature elasto-plastic cyclic straining at 700 °C. The isothermal cyclic tests without and with a dwell in the loading cycle were implemented. Several strain amplitudes and optional dwells of 10 minutes in tensile part of the loading cycle were applied to the specimens. Cyclic stress-strain response was recorded, cyclic hardening/softening curves and fatigue life curves were obtained. Scanning electron microscopy combined with focused ion beam allowed observing sections containing secondary cracks. They were used to identify the surface damage evolution. In order to investigate the internal damage the longitudinal cross sections parallel to the stress axis of the fatigued specimens were prepared. The crack paths and their relation to the grain and twin boundaries were studied by means of electron back scatter diffraction. Several distinct mechanisms of the crack initiation were found in both types of cyclic loading. The effect of the dwell in the loading cycles on fatigue life is discussed in relation to the surface and internal damage evolution.

Keywords

Austenitic steel; Tensile dwell; Surface damage; Internal damage; Fatigue-creep interaction

1. Introduction

In recent decades, the efficiency of power plants has become a challenging issue. The increase of the combustion temperature leading to higher performance is limited by the material. For this purpose the materials with specific characteristics such as high fatigue, creep and corrosion resistance are demanded. Austenitic stainless steel grade UNS S31035 Sanicro 25 represents the material with excellent high temperature strength and corrosion resistance based on an economical compositional balance of alloying element. It has been developed for the next generation of A-USC power plants mainly for use in superheaters and reheaters in advanced coal fired power boilers which can resist temperatures up to 700 °C [1].

Reliable, safe and sustainable service represents the requirement that have become crucial nowadays. The assessment of potential deterioration mechanism and its use in design is

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