High-temperature deformation behavior of Nb-stabilized austenitic stainless steels

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High-temperature stainless steels are an important class of high-temperature materials used for many critical components in ultra-supercritical power plants. Typically, the advanced grade of austenitic stainless steel, namely 304HCu (Super304H) and 347H, contain Nb (0.3-0.6 wt%) in addition to other alloying elements. These alloys derive their superior high-temperature mechanical properties due to MX (Nb-C,N) and $M_{23}C_6$ precipitates. Besides, in 304HCu, Cu-rich precipitates further enhance the creep strength. There have been reports in the literature aimed at understanding the thermal stability and microstructural evolution after prolonged exposure at the typical operating temperatures. However, a thorough understanding of the high-temperature deformation of these alloys over a wider range of strain rates and temperatures is limited. Therefore, the present study aims to address the role of microconstituents on high-temperature deformation of two widely used high-temperature austenitic stainless steels, 304HCu and 347H. In the present study, tensile tests were carried out on 304HCu and 347H alloys in the temperature range of 200°C to 750°C and in the strain rates range of 10^{-2} to $10^{-5}s^{-1}$. Quasi-static flow curves revealed dynamic strain aging in these alloys. Besides, constant load creep tests were conducted at 700°C. Furthermore, deformation parameters were evaluated to identify the rate-controlling mechanisms. The high-temperature deformation mechanisms in these two alloys are elucidated by correlating the flow behavior with microstructural evolution.

Keywords: Stainless steels, high-temperature deformation, dynamic strain aging, creep