Abstract

Super 304H is a copper-containing austenitic stainless steel with potential applications in advanced thermal power plants owing to its superior corrosion, oxidation, creep resistances and cost affordability. The addition of copper has been reported to improve high temperature strength and creep resistance of 304H, but with a loss of room temperature strength. The causes of this effect are not well understood since addition of copper affects several microstructural features simultaneously. *The aim of this work is to shed light on the key microstructural effects of copper on mechanical response at room and high temperatures.* Towards this aim, the effect of copper addition on the mechanical and microstructural properties of three alloys based on 304H and with three different levels (1, 3 and 5wt. %) of Cu was studied. These alloys were given solution and ageing treatments. Mechanical properties of the heat-treated alloys were evaluated by means of room temperature hardness measurements and constant strain rate tests at room temperature and 650^0C. Microstructural characterization was conducted on undeformed and deformed samples by SEM-EBSD, XRD, TEM and 3dAP. It was found that in the as-solutionized condition, yield stress, hardness and strain hardening decreased on small additions of Cu (upto 3%), but increased on further additions. Significant enhancement in the room and high temperature strength was achieved on ageing, but only in alloys with 3 and 5% Cu. 3dAP and TEM studies confirm the presence of ultrafine (<10nm) copper precipitates in 3Cu and 5Cu alloys in both as-solutionised and aged conditions, with a higher volume fraction and number density in the aged alloys. TEM also reveals extensive interactions between Cu precipitates and dislocations in both undeformed and deformed samples. The effect of copper content and heat treatment on strength can be justified by accounting for two effects: copper solute softening due to suppression of strain-induced martensite formation and, copper precipitate strengthening due to lattice and modulus mismatch between the copper precipitates and the matrix. Dissolution of Cu precipitates on grain boundaries during solution treatment results in abnormal grain growth and changes twin boundary fraction as well. However, these microstructural changes due to copper addition have only a secondary effect on mechanical properties.