APT CHARACTERIZATION OF A HIGH STRENGTH CORROSION-RESISTANT Ni-Cr-Mo HASTELLOY® C-22HS™ ALLOY

L.M. Pike*, D.L. Klarstrom* and M. K. Miller#
*Haynes International, Inc., 1020 West Park Avenue, Kokomo, IN 46904-9013, USA
#Metals and Ceramics Division, Oak Ridge National Laboratory,
Oak Ridge, TN 37831-6136, USA

The versatile C-type Ni-Cr-Mo alloys are well known for their corrosion resistance. These alloys have been used for many years in a wide variety of applications such as heat exchangers, scrubbers, reaction vessels, etc. as they exhibit significantly higher strength than most stainless steels. The strength of these alloys may be further increased by cold working. However, this mechanical processing approach limits the size and geometry of the final components. In addition, the high strength is lost in welds and associated heat affective zones. A new high strength corrosion-resistant alloy Ni-21% Cr-17% Mo, HASTELLOY C-22HS, has recently been developed to overcome these problems. This general purpose corrosion-resistant alloy may be used at temperatures of up to at least 600°C. Potential applications for this corrosion resistant high strength alloy include shafting, agitators, fan blades, hubs, springs, fasteners, valves, dies, rings and gaskets.

The composition of the HASTELLOY C-22HS alloy used in this study was Ni, 20.6 wt. % Cr, 16.6% Mo, 1.1% Fe, 0.33% Al, 0.29% Mn, 0.11% Nb, 0.004% C and 0.004% B. The microstructure of the HASTELLOY C-22HS alloy was characterized in the age hardened condition - 16 h at 705°C, furnace cooled to 605°C, 32 h at 605°C and air cooled. The microstructure of this age hardened alloy was characterized with the Oak Ridge National Laboratory local electrode atom probe.

The corrosion resistance of this alloy in HCl at 52°C and H_2SO_4 at 79°C was found to be similar to N06022 alloy and better than N07725 alloy. The yield strength of this alloy and N06022 were similar in the mill annealed condition. After the age hardening treatment, the 0.2% yield strength of the HASTELLOY C-22HS alloy increased from 222 to 542 MPa. The tensile elongation and the reduction in area of the age hardened alloy were 40% and 50%, respectively at room temperature and 48% and 66%, respectively at 595°C.

Atom probe tomography of the HASTELLOY C-22HS alloy revealed that the microstructure consisted of fine (~10-30 nm diameter) approximately spherical molybdenum–enriched Ni_2(Cr, Mo) precipitates in an aluminum-, iron-, silicon-, and manganese-enriched matrix. The morphology of these precipitates was significantly finer than the lenticular Ni_2(Cr, Mo) precipitates previously observed in a HAYNES 242 alloy [1].

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1. M. K. Miller, I. M. Anderson, L. M. Pike and D. L. Klarstrom, *Mater. Sci. Eng. A*, **327** (2002) 89-93.