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Effect of solution heat treatment in nanoscale mechanical properties of ASTM A 744Gr. CN3Mn superaustenitic stainless steel

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Abstract – Nanoscale mechanical properties of ASTM A 744Gr. CN3Mn superaustenitic stainless steel was obtained by instrumented indentation. Samples submitted to solution heat treatment of 1200°C and 1240°C were studied. Nanoindentation tests indicated that hardness at near surface is 6.5 GPa. At contact depths of 2700 nm the hardenss was 2.5 GPa. Elastic modulus measured by instrumented indentation of this material was 210 GPa. Hardness measurements do not show difference between samples submitted to different thermal treatments.

ASTM A 744Gr. CN3Mn superaustenitic stainless steel is used in several applications. Elements as Cr and Mo are used to improve the corrosion resistence properties and the Ni is used to stability the austenitic phase. The term “superaustenitic stainless steel” denotes materials with high quantity of Cr, Ni, Mo and/or N. The samples analized in this work were submitted to heat treatment at 1200°C and 1240°C to dilute the precipitates formed during the solidification process. Nanoscale mechanical properties as hardness and elastic modulus were determined using instrumented indentation with a Berkovich indenter. The load versus displacement data were analyzed using the Oliver and Pharr method [1,2]. X-ray diffraction data (XRD) were used to determine the structural properties of matrix phase (γ-austenite) and the σ-phase. Strucural characterization was analyzed by Rietveld refinement using the XRD data. The Fig. 1 shows the hardness profile for two heat treatment conditions. At near surface region (contact depth = 250 nm) the hardness was aproximately 6.5 GPa for both materials. Hardness measurements decreased to 2.5 GPa (in both samples) for contact depth > 2000 nm. This behavior is a result of surface hardening effect of presence of σ-phase and carbide M_6C analyzed in previous work [3] and due to polishing [2]. In both materials the elastic modulus was aproximately 210 GPa. The results obtained in this work indicated that the nanomechanical properties values obtained for this superaustenitic steel are compared with the values obtained for austenitic stainless steels. The surface hardening the superaustenitic steel and the common austenitic steel is investigated by analysis of structural modifications induced by σ-phase and by mechanical polishing.

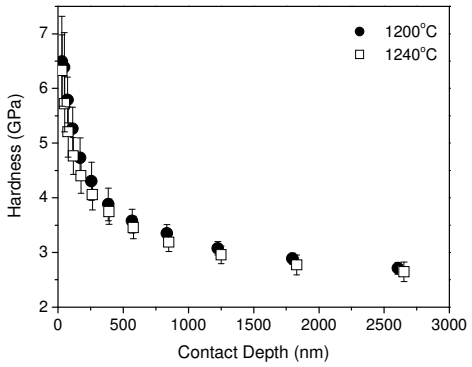

Figure 1: Instrumented indentation hardenss profiles of ASTM A 744Gr. CN3Mn superaustenitic stainless steel for different solution heat treatment.

References

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