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Application of Magnetic Barkhausen Emmision Technique in Texture Analysis of Cold Rolled and Aged 304 Stainless Steel

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Abstract

Austenitic 304 stainless steel (SS), which is stable at room temperature, transforms to martensite phase either by cooling to subzero temperature or by plastic deformation [1-2]. The magnitude of transformation on subzero treatment depends on prior austenite grain size as well as chemistry of the steel and also on deformation process depending upon temperature and amount of deformation. Cold rolling of stainless steels imparts crystallographic texture in both the parent austenite phase and strain induced martensite phase formed due to cold rolling. Crystallographic texture is conventionally determined by X-ray diffraction technique. However, in the recent past attempts have been made to study the crystallographic texture in the material by non-destructive techniques[3-5]. In the present investigation, an attempt has been made to make use of Magnetic Barkhausen Emission technique to determine texture in the AISI 304SS. This material has been chosen for this study as it transforms from non-magnetic austenitic phase to ferromagnetic martensitic phase during cold rolling and hence suitable for this technique. The chemical analysis of the steel is shown in Table 1. The steel plate has been unidirectionally rolled upto 90 % reductions. The transformation of austenite to marensite phase and evolution of magnetic anisotropy/texture in martensitic phase has been studied as a function of rolling reduction. The 90% cold rolled material was further aged at different temperatures to study variation in texture in aged condition. The X-ray diffraction technique has been employed to quantify the volume fractions of austenite and martensite phases in rolled and aged conditions. Texture measurements have been carried using Schultz reflection technique. The pole figures of (111), (200) and (220) planes for austenite phase and (110), (200) and (211) planes for martensite phase have been selected for texture analysis. For magnetic texture analysis, the surface probe of Barkhausen system was rotated through 360^o at an increment of 15^0 for each sample to change the magnetic field orientation. The magnetic pole figures corresponds to the distribution of M_{max}, the maximum amplitude of Barkhausen noise, with field orientations.

The magnetic pole figures has been observed from 30% cold reduction and onwards having maximum magnetic anisotropy in the rolling direction. An increase in magnetic anisotropy till 50% of cold reduction then decrease has been noticed for cold rolled materials. Whereas it has been observed that the magnetic anisotropy increases with cold reduction for aged materials. The results of Magnetic Barkhausen Emission technique compare well with the convetional x-ray diffraction technique.

Table 1: Chemical composition of the 304 stainless steel

Elements	C	Si	Mn	P	S	Cr	Ni	N
Wt. %	0.03	0.54	1.8	0.028	0.014	18.55	9.5	0.04

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