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Microstructural Characterization of the Effect Cementation Treatment on Microalloyed Steel Boronizing

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Thermochemical treatments have been implemented to expand the versatility of surface microstructural properties in microalloyed steel used in conditions of high temperatures, wear, corrosion, erosion, fatigue, and embrittlement hydrogen [1-2]. Thermochemical treatments are used as an alternative to improve surface properties. Pack Boriding in ferrous and nonferrous alloys can be carried out between temperatures of 1073 K and 1323K [3] and Pack cementation is considered as an industrial coating technique, it typically requires process temperature of 1083-1223K. In the present study, the microstructure has been investigated the effect on cementation on microalloyed steel borided, also the nanohardness obtained in the coatings.

The microalloyed steel was studied with chemical composition; C-0.012, Mn-1.48, Si-0.27, P-0.012 S-0.008, Al-0.039, Nb-0.041, Cu-0.006, Mo-0.032, Ti- 0.009, V-0.048 (% weight) and dimensions of 10 mm x 7.5 mm. Prior to the boriding process, the samples were sanded with 80 to 600 grade carbide abrasive paper and cleaned with alcohol. Dehydrated paste pack boriding [4], was carried out at 1273 K for 8 h. After, samples of microalloyed steel borided were exposed to the cementation process by powder pack (charcoal, coke, sodium carbonate, barium carbonate, and calcium chloride) at 1173 K for 12 h. In both processes, the treatments were carried out in a conventional furnace without the use of a controlled atmosphere, at the end of each process the cooling was at room temperature. The surface treated samples were cross-sectioned, mounted and prepared for metallographic preparation; the polished samples were etched in a 2% nital solution to observed the coatings. The microstructural characterization produced by the boride and cementation process were analyzed by Scanning Electron Microscope (SEM) with Energy Dispersive Spectroscopy (EDS) using JEOL 6010 LV, X-Ray Diffraction (XRD) with equipment Bruker D8 Advance and nanohardness was established by depth sensing instrument indentation testing using an ultra micro Hardness Tester DUH211s with indentation load of 100 mN.

Figure 1a shows the cross-sections of FeB/Fe_2B formed on the surface of microalloyed steel and the cementation and Fe_2B coatings are observed in Figure 1b with removing the FeB phase. The formation of FeB+Fe_2B coatings and single Fe_2B coating were confirmed by XRD, as shown in Figure 2a and Figure 2b, respectively. Fe_2B and FeB within the boride coating exhibit substantially different coefficients of thermal which cause microcracks in the interface Feb/Fe_2B, so the formation of the FeB coating is often considered undesirable. Moreover, in Figure 3a shows the image (SEM) of hardness tests on surface microstructural across Boronizing and Cementation process. A schematic representation of the load-displacement curves obtained in the Cementation/Fe_2B coating is shown in Figure 3b. The values of nanohardness obtained in cementation coating were obtained from range of 738.3 to 762.5 23 Hv and the Fe_2B coating in the range of to 1223.46 to 1792.6 Hv. This paper presents a contribution in the modification of the microstructural and eliminate the FeB coating by the pack Cementation process, as well as enhance the mechanical surface on microalloyed steels for industrial applications.

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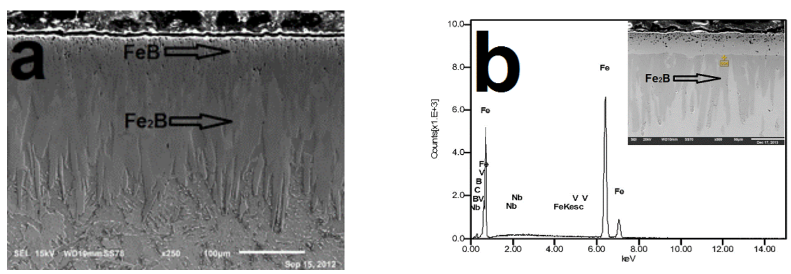

Figure 1. Microalloyed steel treatment a) SEM cross-sectional micrograph on sample borided and b) EDS spectrum of Fe_2B coating after the pack cementation.

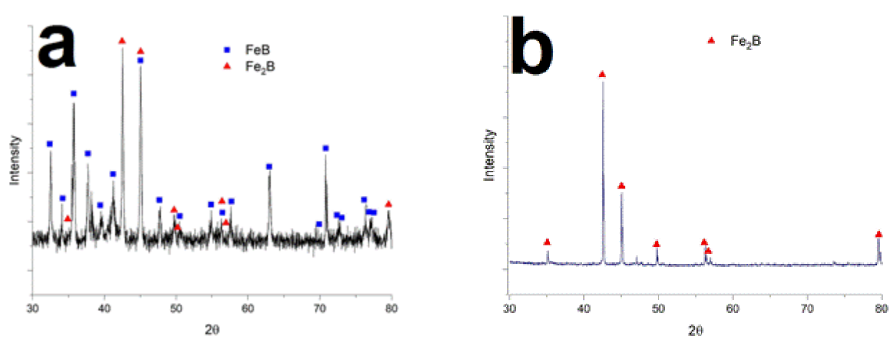

Figure 2. X-ray diffraction patterns on microalloyed steels a) borided coatings and b) effect of cementation on the boride coatings.

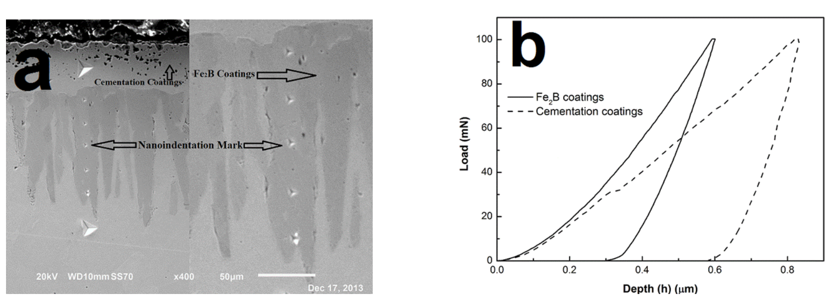

Figure 3. Nanoindentation performed across the boride-cementation coatings a) SEM image of nanoindentation and b) load-displacement curves obtained in Fe_2B and cementation coatings.

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