Grazing incidence synchrotron X-ray difraction and Mössbauer spectroscopy analyses of plasma nitrided ASTM F138 stainless steel

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A systematic investigation of samples of plasma-nitriding austenitic stainless steels ASTM F138 and AISI 316L is reported. The surface treatment of the steels through plasma-nitriding was used to improve further the hardness, wear and corrosion resistance of these stainless steels. The resulting layered crystallographic structure actually corresponds to several phases with close cell parameters, making their identification and quantification a real experimental challenge. The ASTM F138 and AISI 316L stainless steel disks were plasma-nitrided for 4 h at 400 ºC in a 80% H_2 -20% N_2 atmosphere at 6 torr, using plasma current frequencies between 6 and 100 kHz. Data of Mössbauer (CEMS and CXMS) and grazing incidence synchrotron X-ray diffraction (XRD-SR) were systematically collected. The nitrided layer thickness were not in general influenced by the plasma frequency, except at 12 kHz, which produced a layer thickness of approximately 8.0 mm, being in average 40% thicker than for the other samples. CXMS and CEMS Mössbauer spectra for this 12 kHz-sample show a much more pronounced magnetic resonance lines than for the other samples. The Fe_4N phase presents a single magnetic hyperfine interaction; the other two ($Fe_{2-3}N$ and the expanded austenite) present both paramagnetic and magnetic components, even though their hyperfine parameters may not be safely separated. We also present the results of XRD-SR that were probed at several depths. The data from these techniques may be consistently correlated and this leads to an improved model to explain the structure of the nitrided layers.

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