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Characterization of ε and γ' Produced by Microwave

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Post-discharge microwave and plasma nitriding are used to improve material surface properties in steels such as hardness, strength, wear and corrosion resistance [1-4]. The reactive atmospheres, in post-discharge nitriding, are mainly composed of neutral excited species, which results in faster nitride growth kinetics compared to the conventional process [5], normally associated to a rapid nitrogen surface saturation. There are significant improvements in mechanical properties following different nitriding treatments but variations in corrosion behavior have been reported depending upon steel composition and process parameters. The steel samples were nitrided at 810 K between 5 and 25 minutes. The microstructure and the nitride layer were analyzed by X-ray diffractometry, scanning electron microscopy (SEM), the HRTEM analysis were carried out using a FEG TEM TECNAI F20 microscope with analytical equipments attached. Rectangular specimens (10 × 20 × 20 mm) were cut from an AISI SAE 4140 steel bar with a composition (in wt.%) corresponding to 0.412 C, 0.665 Mn, 0.23 Si, 0.015 P, 0.014 S, 1.15 Cr, 0.15 Mo and 0.50 Ni. The sample surface to be exposed was polished down to 3 μm and thoroughly cleaned in an acetone ultrasonic bath before nitriding. Nitriding experiments were carried out in a post-discharge flow of plasma generated in the microwave reactor, which is described in previous works [5,6]. Figure 1 shows typical X-ray diffraction spectra treated for 5 min (fig. 1a), 15 min and untreated sample (fig. 1b) and 25 min (fig. 1c) respectively. The X-ray diffraction analysis shows that the formation of the ε - $Fe_{2-3}N$ and γ' – Fe_4N on the top of the surface occurs at short treatment time. On other hand, the intensity of the γ' – Fe_4N diffraction lines increases with respect to time. The ε - $Fe_{2-3}N$ phase intensity gradually decreases with the treatment time duration, indicating a decrement in the amount of this phase, while the γ' – Fe_4N diffraction lines intensity increase with the treatment time duration. Figure 2 show an HRTEM of the γ'-Fe_4N nitride of a ffc- like structure formed with 5 minutes of treatment, with interatomic distance of 0.268 nm in the (110) zone axis.

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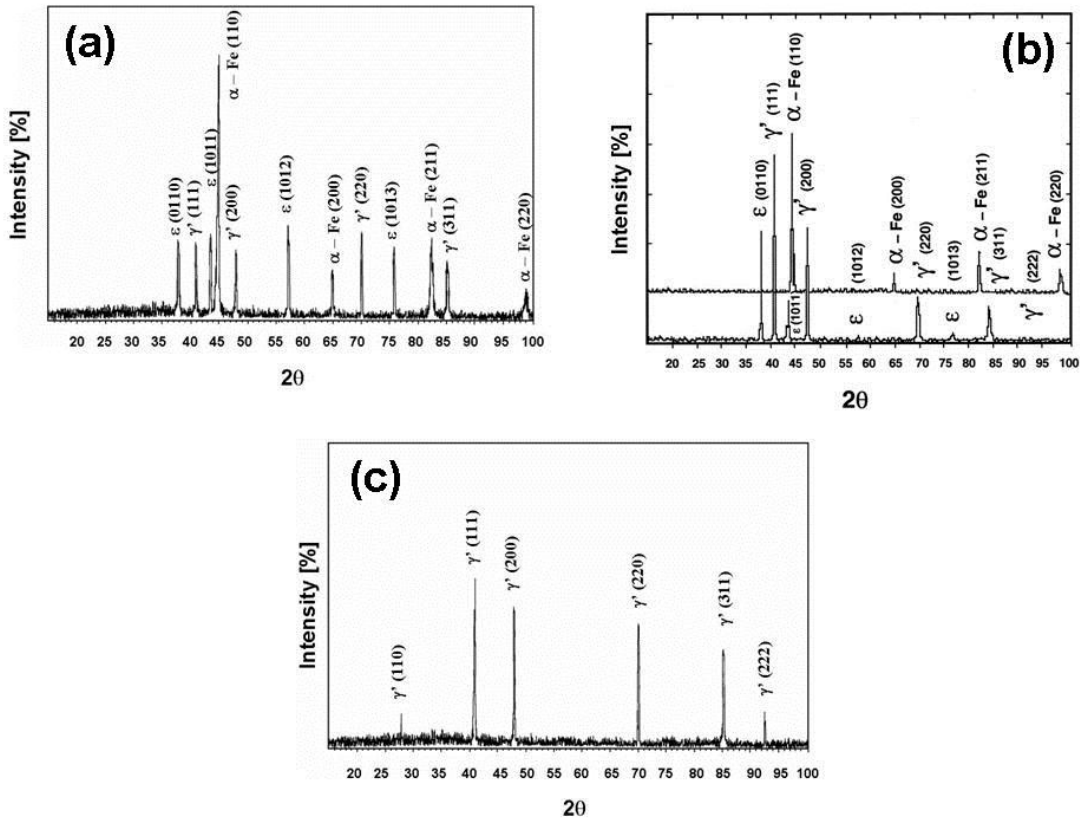

Figure 1: X-ray diffractograms of the untreated and nitriding samples (a) 5, (b) 15 and untreated sample and (c) 25 minutes.

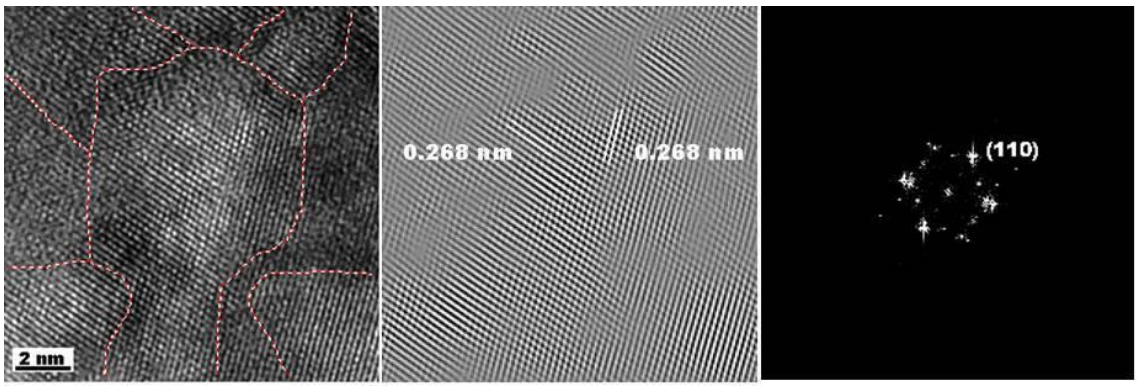

Figure 2: HRTEM image of the of γ'-Fe_4N_{1-x} nitride with 5 minutes of treatment (a) HRTEM of γ'-Fe_4N_{1-x} nitride, (b) IFFT of the γ'-Fe_4N_{1-x} nitride showing interatomic distance of 0.268 nm in the (110) plane, (c) FFT in the (110) zone axis.

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