

EFFECT OF THE NANOCRYSTALLIZATION ON PURE IRON NITRIDING KINETICS

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Extended Abstract : Gas nitriding has been used to improve the mechanical properties and corrosion resistance of components made of steel. This thermochemical surface treatment is performed using a flowing NH₃, N₂ gas mixture. The gas nitriding is usually performed at a temperature between 500 to 580°C for typically durations of 20 to 80h which involve very long cycle times. A pre-treatment of the sample surface by shot peening can be applied to produce nanocrystalline grains. This surface treatment enhances the nitrogen diffusion [1, 2].

The purpose of our study is to investigate the effect of nanocrystallization of pure iron samples on nitriding kinetics. Pure iron samples obtained by cold crucible melting have been submitted to short duration or long duration NanoPeening® treatments. The samples are cuts in 5 mm thick pins in the cylindrical ingots (diameter 11 mm). Both sides of the pins receive the shot peening treatment. The pins are then cutted under water into 1 mm thick disks. The untreated surface is polished with SiC abrasive paper. For comparison, untreated shot peening iron disks (NG) are also prepared. The gas nitriding isothermal tests are performed at 500°C under NH₃, N₂, He mixture in a SETARAM TAG 24 thermobalance. The nitriding durations vary from 10 to 210 minutes. After the gas nitriding, the samples are first analysed by XRD. The nitrogen profiles are measured by GDOES (Glow Discharge Optical Emission Spectrometry). Finally, the machining and cross sectional electronics views of the samples are achieved in a FIB (Focused Ion Beam).

FIG. 1 a) and b) presents respectively the mass gain curves for the short duration (NPS) and long duration (NPL) shot peening samples. The maximal values of the mass gain are obtained for the NPL

samples. The nitriding mass gain rates are also more reproducible for the long duration treated nanocrystalline iron samples.

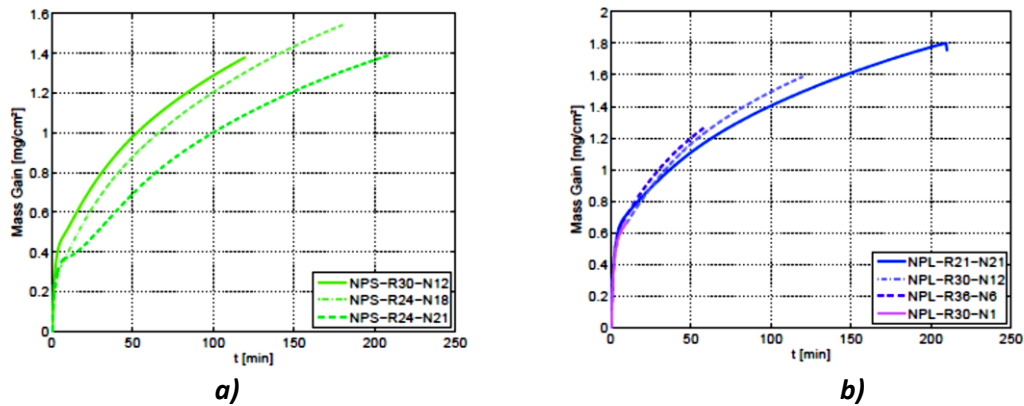


Figure 1 : a) NPS samples b) NPL samples

Fig. 2 presents the nitrogen concentration profiles for each type of samples. The nitride depth increases with the nitriding duration and with the surface treatment. The concentration profile of the untreated pure iron sample presents a front at around 8 μm . The surface of the nitride layers contains γ' and ϵ iron nitride phases, then in the bulk material, nitrogen is dissolved in iron matrix.

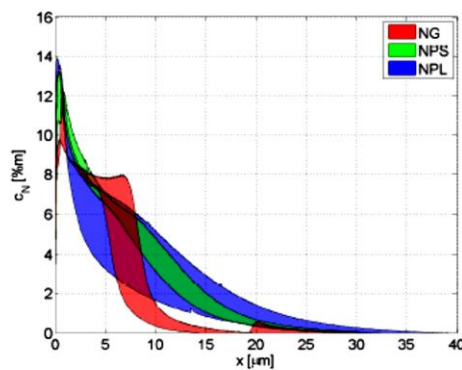


Figure 2 : Concentrations profiles of nitrogen

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