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Plasma Nitriding of sintered unalloyed iron superficially enriched with Mo

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Abstract – PM (Powder Metallurgy) unalloyed iron samples were superficially alloyed with Mo during plasma sintering and followed by plasma nitrided treatment. Both processes were performed in the same reactor. The characterization of the samples was carried out by SEM (Scanning Electron Microscope), OM (Optic Microscope) e XRD (X-Ray Diffraction). Significant increase in the hardness values were observed for samples enriched and nitrided. This behavior was attributed to the precipitation of nitrides and the presence of Mo in solid solution.

DC Plasma is frequently applied in thermochemical treatments, mainly nitriding and layer depositions. Furthermore, this technique has been recently used to sinter and enrich alloy elements in the surface of components obtained by powder metallurgy technology. In this context, samples of unalloyed iron sintered and superficially enriched with molybdenum were nitrided by means of DC plasma. The Mo enrichment was carried out at 1150 ^{o}C in a gas mixture of 80% Ar and 20% H_2. The nitriding were performed at 450 ^{o}C and 540 ^{o}C using gas mixtures of 75%-N_2/25%-H_2 and 5%-N_2/95%-H_2. For comparison proposes, another set of samples without Mo enrichment were nitrided in the same conditions.

The microstructure characterization was done by SEM, OM and the phases present in the surface were identified by XRD. Microhardness profile was performed for all the nitrided samples. Images acquired by OM and SEM of the Mo enrichment samples nitrided at 540 ^{o}C and 75% N_2 are shown in Figure 1, were three distinct regions can be observed. The upper layer, or region 1, refers to the compound layer followed by the region 2, were a lamellar morphology can be observed. This microstructure is similar to the discontinuous precipitation of iron nitrides, also identified as transformed austenite [2], or similar to perlite in carbon steels [3], characterized as a region with many precipitates and high content of N_2. The region 3 is characterized as the diffusion zone with nitrides precipitates γ'-Fe_4N and α''-$Fe_{16}N_2$ and/or ε – $Fe_{2-3}N$.

The XRD analysis does not show the presence of molybdenum nitrides as well as mixed Fe-Mo nitrides. The absence of peaks referred to these compounds could be attributed to low Mo concentration (3 wt %), and therefore, few nitrides precipitates. In contrast to the XRD analysis, it was observed a significant increase in the hardness values for the samples surface enriched by Mo and nitrided. This increase could be related to the precipitation of very thin molybdenum nitrides or Fe-Mo mixed nitrides not detectable by XRD. Moreover, these increase could be also attributed the increased nitrogen concentration in the ferritic matrix owing to the presence of Mo, which deform the crystalline lattice within this enriched region resulting in higher values of hardness.

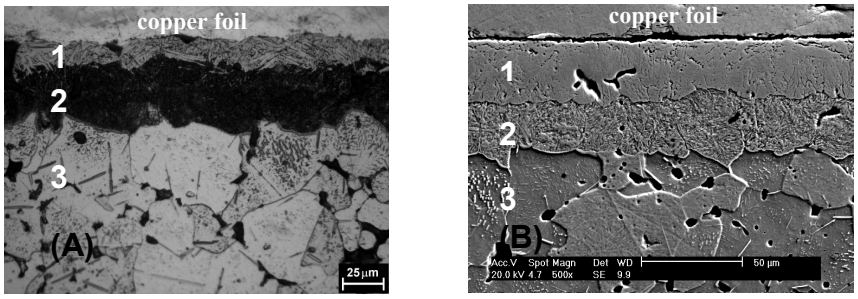

Figure 1: Cross-sectional views of iron samples enriched with Mo and nitrided at 540 ^{o}C and 75% de N_2. **a**) OM **b)** SEM

References

[1] Hammes, G, Binder, C., Perin, L.L., Pavanati, H.C., Klein, A.N., In 61^{o} Congresso Annual ABM, (2006).
[2] Gontijo, L.C.,et. al., Surface Coatings and Techonology, 183, (2004), 10-17.
[3] R.F.Reis, W.H. Schreier, P.C. Borges, Rev. Brasileira de Aplic. de Vácuo, 25, (2006), 183-187.