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Electroless Deposition of Pure Nickel Black Film Over a Ceramic Substrate

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Abstract – A stable electroless plating solution for pure nickel deposits have been developed using hydrazine as reducing agent. The support consisted in a non conductive ceramic which was previously treated and after the deposition it was completely covered by an adherent metallic film with a high degree of purity, as no additives were employed, the deposit is black in its appearance. The possibility of obtain a metallic film over non conductive surfaces with characteristics such as those found in nickel black allow its application in a large number of fields, such as catalyst in fuel cells or in solar collectors.

Electroless nickel is widely used in many industries and in general the obtained films include phosphorus and boron in their structure due to the reducing agents employed in their fabrication processes. These elements affect the nickel films properties, mainly the conductivity. Thus, it's interesting to obtain pure nickel deposits which can be used in many fields, like electronics industries, as catalyst for many reactions and renewable energy. The mainly form to obtain nickel black from electroless deposits is through a common Ni-P deposition process and a post-etched treatment to blackening the surface [1,2]. Some attempts to obtain pure nickel film were made and good results were obtained [3,4]. Black films were produced and to turn then bright some additives were added to the plating bath.

This work consisted in develop a stable plating bath in order to obtain deposits of nickel black and characterize these deposits for further use as catalysts in fuel cells.

The Ni black was plated over a non conductive ceramic piece previously treated with a sensitization and nucleation procedure which provides a thin layer of Pd in order to turn the surface catalytic for the electroless deposition and improve the film adhesion. The plating bath was stable and composed by $NiSO_4.6H_2O$ 0.05 mol dm^{-3}, ethylenediamine 0.15 mol dm^{-3}, NH_4OH 6 mol dm^{-3} and hydrazine 0.1 mol dm^{-3}. The deposition time was 100 minutes at 85 ºC.

A layer of 8.48 µm of nickel black with a deposition rate of 2.56 mg/h cm2, was obtained through the methodology described above. The film is very compact with some holes distributed all over the surface (Fig. 1a). These holes can be attributed to defects in the lateral nuclei coalescence, however when the nuclei coalesce their borders can be observed, this feature causes a degree of roughness to the deposit. The existence of these holes do not imply in substrate exposition, once the base is completely covered by the metal (Fig. 1b). Is also possible to observe that the nuclei are formed by tiny needles, which can improve the active area. Structurally the nickel black deposit is polycrystalline, as can be observed in the diffraction pattern in figure 2, the peaks not labeled belong to the substrate and are due to high X-Ray beam penetration into the film.

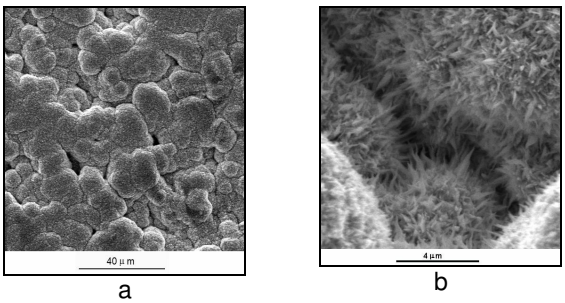

Figure 1: Micrographies of Ni catalyst obtained by electroless deposition. Magnifications of 1000 X and 10000 X.

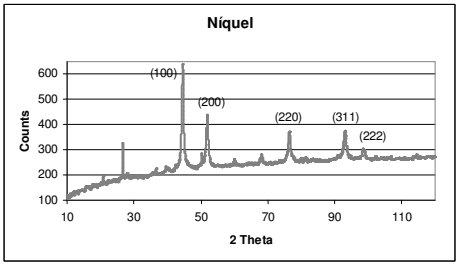

Figure 2: XRD pattern of the Ni black deposit.

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