Nanocomposite electroplating. Electrochemical aspects, structure and properties.

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Deposition of electrochemical composite coatings [ECC] is not a newly developed technique [1], but has been in continuous development since the 1970's [2-4]. The steady interest is explained by easy maintainability and low cost of ECC manufacture as well as by a possibility of changing the properties and adapting them to many applications.

The fabrication of nanocomposite films can be achieved through electrochemical deposition of the matrix material (e.g. metal, alloy, semiconductor, oxide, conducting polymer) from a solution containing a suspension of particles such as: oxides, carbides, nitrides, metal powder and s.a. This technique has been used for the fabrication of our nanocomposite coating tested, using nanometer size SiC particles.

Nanocomposite coatings are obtained by electrochemical deposition of silicon carbide nanoparticles (mean diameter 20 nm) in a nickel plating bath. The influence of nanoparticles on nickel electroplating is studied by electrochemical impedance spectroscopy at cathodic potential (Fig. 1) and cathodic polarization diagrams performed in the electrolyte without nanoparticles and in the suspension of them. We show that incorporation of 20 nm SiC particles into nickel deposition modify the impedance and cathodic polarization diagrams in correlation with the modification on the texture and surface morphology of nickel matrix.

Cathodic polarization and impedance diagrams were performed in the electrolyte without and in the presence of particles in order to observe the influence of dispersed nanocrystals of SiC on the nickel reduction. The uniformity of the dispersed phase distribution and the surface quantitative analysis of the composite coatings were examined by SEM with an EDS system. SEM also revealed the comparative surface morphology of pure nickel and composite coatings in relation with their fibber textures (See Figs. 2, 3). The presence of particles inside of the composite coatings was detected by X-ray diffraction and directly observed by TEM. It is shown that although the weak rate of incorporation the nano SiC (maximum obtained was 25 volume percent) modify the impedance and cathodic polarization diagrams in correlation with the changes on the texture and surface morphology of nickel matrix. The corrosion properties of composite coating are improved comparative with pure nickel coating (electrochemical, salt spray and wear corrosion).

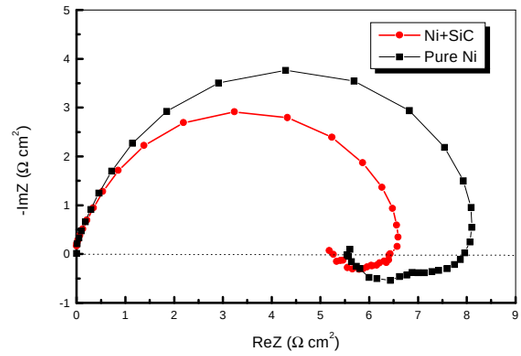

Fig. 1. Impedance diagrams performed at cathodic potential of –750mV (Ag/AgCl): (solid circle)- codeposition of nano-SiC with nickel, (solid square)- pure nickel electrodeposition. Disks rotation 200 rpm

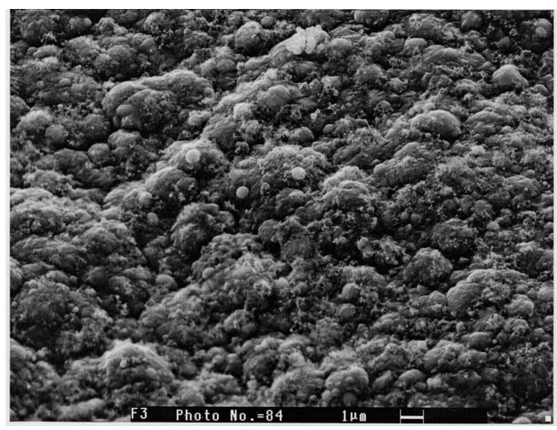

Fig. 2. SEM surface morphology of nano-structured composite coating

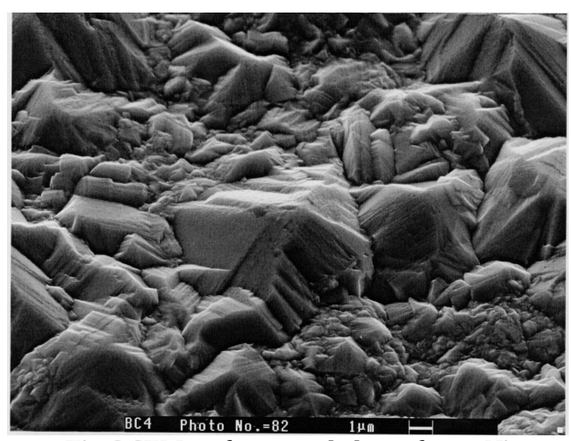

Fig. 3 SEM surface morphology of pure Ni electroplating

References

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