WEAR RESISTANT NICKEL DISPERSION LAYERS PRODUCED USING PULSE PLATING

A. Staudinger, S. Hansal, W.E.G. Hansal J. Kölndorfer, T. Steck, C. Suarez, J.O.Besenhard, H.Kronberger, G. E. Nauer

ECHEM Center of Competence in
Applied Electrochemistry
Viktor Kaplan Straße 2, 2700 Wiener Neustadt
Austria

Electrodeposition of metals by using pulse plating techniques has beneficial effects on the deposited layer's mechanical and tribological properties and results in most cases in smoother and less porous coatings then those produced by direct current methods [1]. As further effects, corrosion- and wear-resistance are usually increased [2,3]. For purposes which demand durability under conditions of enhanced or even extreme wear, e.g. for automotive parts in engines, the wear resistance can be considerably further increased by inclusion of solid particles into the metal coating ("dispersion layers", "composite coatings") [4]. This is done by electrodepositing the metal out of a bath, which – beside the usual constituents – is a vigorously stirred suspension of the particles to be enclosed.

In order to test the above statements, a comparison of the abrasive properties of three types of nickel layers on a steel substrate has been made: 1) a composite nickel coating containing silicon carbide (SiC) particles (average diameter 1 µm) deposited under pulse plating conditions, (see Figure 1 for an example of the applied pulses) 2) a conventional direct current (DC) pure nickel layer and 3) a pulse plated pure nickel layer. The silicon carbide particles were embedded homogenously across the metal surface during the nickel deposition (Fig.3). The bigger part of the silicon carbide particles are completely covered by the nickel matrix. Figure 2 shows an Energy Dispersive X-ray spectrum (EDX) of the resulting surface, proving the incorporation of a certain level of silicon carbide within the nickel layer.

The durability of the produced layers against abrasive wear was investigated by rotating the samples in a tumbling barrel, which was filled with aluminum oxide particles for simulating enhanced wear conditions.

Investigations of the treated surfaces with the light microscope proved a superior wear resistance of the pulse plated pure nickel layer compared to the pure nickel layer produced by conventional DC for different times of exposure to the abrasive treatment.

A significant higher wear resistance was observed for the layers including silicon carbide particles. Even after a treatment for two hours, no abrasion could be noticed at the nickel surface.

Acknowledgement
This work is supported by the K*plus* program of the Austrian government.

Literature

[1] Kim W., Weil R.; „*Surface and Coatings Technology*" 31 (1987) 143-150
[2] Jeong D.H., Gonzalez F.; „*Scripta mater.*" 44 (2001) 493-499
[3] Tang P.T., Watanabe T.; „*Journal of Applied Electrochemistry*" 25 (1995) 347-352
[4] Orlovskaja L., Periene N.; „*Surface and Coatings Technology*" 111 (1999) 234-239

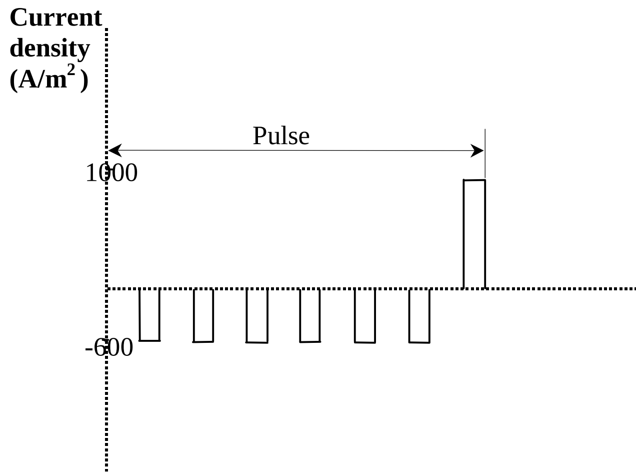

Fig. 1: Example of a pulse program for the electrodeposition of nickel from a Watts-type bath.

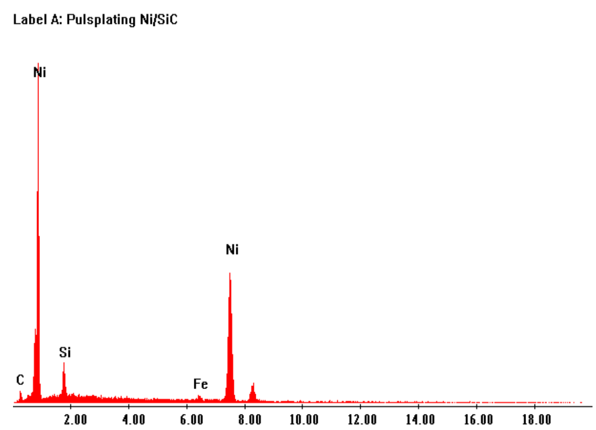

Fig. 2: EDX-spectrum proving the inclusion of SiC in the nickel layer.

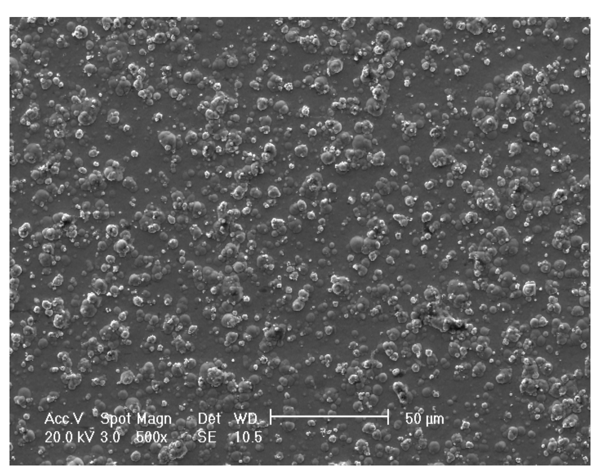

Fig. 3: SiC-nickel dispersion layer on a steel substrate (ESEM, magnification: 500×)