

COST OFFICE
SHORT-TERM SCIENTIFIC MISSIONS (STSM)



SHORT-TERM SCIENTIFIC MISSIONS

COST Action number: 532
Working Group number: *WG3 Tribochemistry*
Applicant's name and Institution: *BENEA LIDIA, Dunarea de Jos University of Galati, Dept. Of Metallurgy and Materials Science, ROMANIA*
Host's name and Institution: *Pier Luigi BONORA, Trento University, Dept. Of Materials Engineering, ITALY*
Period of the STSM: *from 19/04/2004 to 18/05/2004*
STSM Place: *Industrial Corrosion Control Laboratory*

SCIENTIFIC REPORT

Purpose of the visit

The visit is connected with the COST 532 Project M1 (Working Group WG3) titled: ***“Nano-structured composite coatings obtained by electrodeposition to be used in tribocorrosion systems: processing and properties investigation”***, under the coordination of Dr. Lidia BENEÀ, "Dunarea de Jos" University of Galati. This STSM mission gave the opportunity to do few common work at Trento University, Dept. of Materials Engineering, Industrial Corrosion Laboratory, Italy. The M1 project has as partner the Italian institution.

Description of the work carried out during the visit

The work was focused on

- Electrochemical methods (cathodic polarisation and electrochemical impedance spectroscopy diagrams performed at cathodic potential) to study the influence of dispersed nanosized particles on the mechanism of nickel reduction.
- Surface characterisation of nanocomposite obtained by SEM and EDX.
- Preparation of 10 samples in a special shape (cylinder with 25 mm diameter and height of 25 mm) to be tested on the tribocorrosion systems. The composite layers have been deposited on top of cylinder as Ni+SiC (nanostructured) and Ni+ZrO₂ (microstructured) composites.

Description of the main results obtained

The results obtained are as follow:

i) Influence of nano SiC particles on nickel electrodeposition was observed by potentiodynamic diagrams and electrochemical impedance spectroscopy measurements performed with and without dispersed particles. Example on Fig. 1 is an impedance diagram (Nyquist representation) plotted at cathodic potential with and without dispersed nanoparticles in the nickel plating bath.

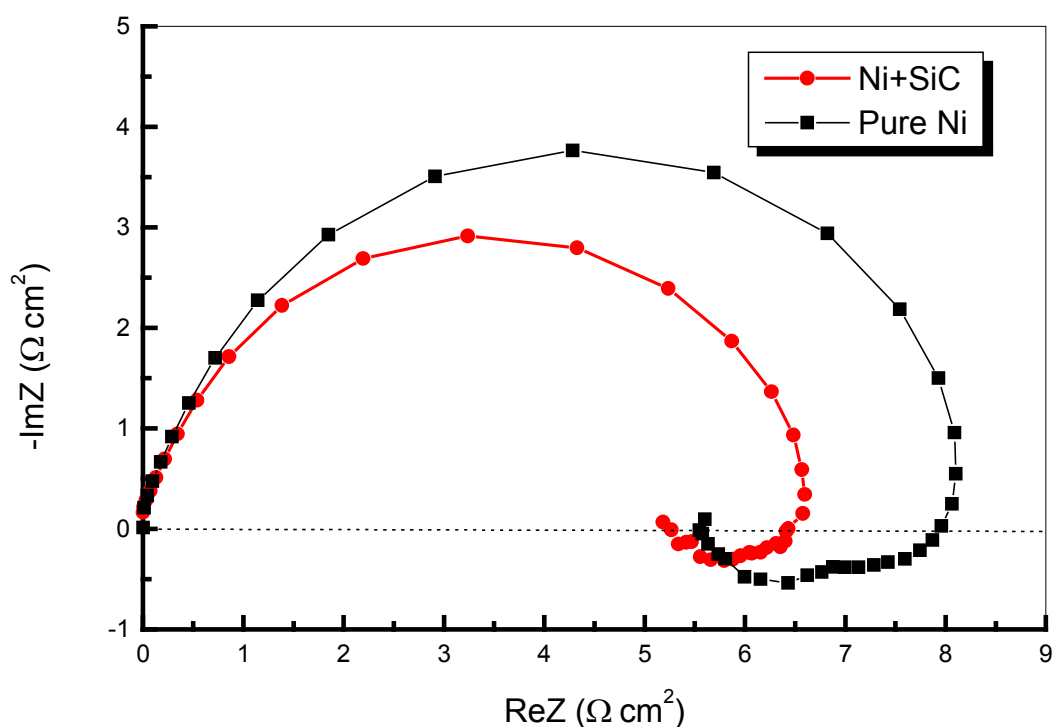


Fig. 1. Impedance diagrams performed at cathodic potential of -750mV (Ag/AgCl): (solid circle)-codeposition of nano-SiC with nickel (50 g/l SiC in the electrolyte), (solid square)-pure nickel electrodeposition

The addition of silicon carbide nanoparticles displaces the nickel reduction curve (Fig. 1) to more positive potentials. The shift in reduction potential were attributed to an increase in the active surface area due to the adsorbed particles on the cathode and to a possible increase in ionic transport by nanoparticles with their ionic layers adsorbed. It is supposed that the nanoparticles are surrounded by a thin layer of (Ni^{2+}) and (H_3O^+) ions adsorbed after the particles were introduced in the electrolyte. These positively charged particles could reach the cathode surface. The negatively charged particles will be rejected to the bulk of the solution.

The characteristic inductive loops at low frequency observed from the Nyquist plots are larger for pure nickel reduction than that for codeposition of nanoparticles with nickel. The adsorption / desorption process of intermediates at/from cathode surface seems to have different times constant in the case of nanoparticles codeposition. The charge transfer resistances were lower in the presence of nano SiC particles and very well defined at -750 mV (Ag/AgCl) reduction potential. Thus in Fig. 1 the charge transfer resistance is about $6.5\ \Omega\text{cm}^2$ for nanocomposite deposition and $8.3\ \Omega\text{cm}^2$ for pure nickel plating at same reduction potential (-750mV vs Ag/AgCl).

It is still a lot of work to calculate and edist all of data obtained.

ii) Structural aspects of nanocomposite coating. The SEM investigations shows that the composite coatings with nanosized dispersed particles develop in a nodular disturbed surface structure. The silicon carbide particles are clearly visible on the surface even if are small dimensions (light grey particles in Fig. 2).

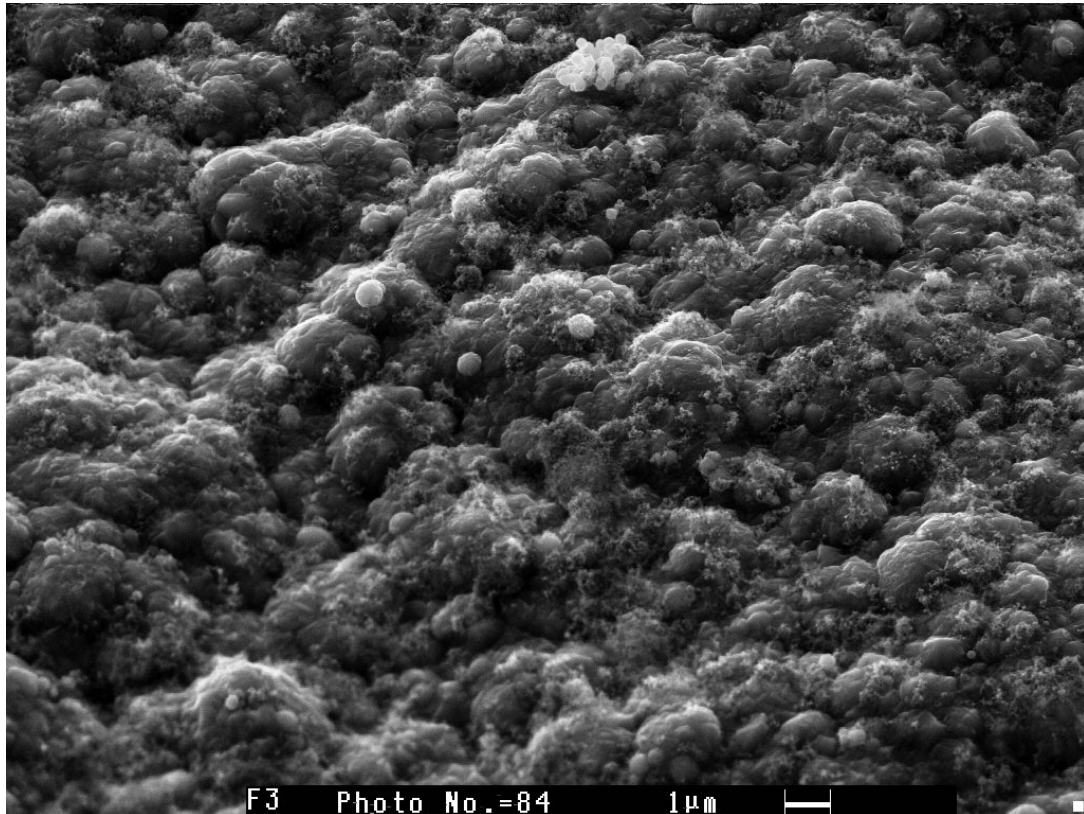


Fig. 2. SEM surface morphology of Ni+SiC nano-structured composite coating

We suppose that the higher density of nucleation sites due to nanosized silicon carbide particles perturb the growth of nickel matrix resulting in smaller grain size and random orientation of nano composite coating.

We obtained also EDX results showing the presence of SiC inside of deposits.

iii) 10 samples in a special shape (cylinder with 25 mm diameter and height of 25 mm) have been obtained to be tested on the tribocorrosion tests. The composite layers have been deposited on top of the cylinder as Ni+SiC (nanostructured) and Ni+ZrO₂ (microstructured) composites.

Future collaboration with host institution (if applicable)

We will continue our collaboration in the field of composite coatings, during the period of COST 532 COST action, to fulfil the project M1 as partners and also we will propose a FP6 joint research project for next call in the field of nanocomposite coatings.

Projected publications/articles resulting or to result from the STSM

The results obtained will be presented at the Annual Meeting of International Society of Electrochemistry (ISE), which will be held in Greece during 19-24 of September 2004. The title of paper will be:

”Study of nanosized SiC particles co-deposition with nickel by electrochemical methods”

with acknowledgment of COST 532 STSM visit.

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After presentation and reviewing the paper will be submitted to *Journal of Applied Electrochemistry* for publication.

Confirmation by the host institute of the successful execution of the mission (e-mail)

----- Original Message -----

From: "Pierluigi Bonora" <Pierluigi.Bonora@ing.unitn.it>

To: <Lidia.Benea@ugal.ro>

Sent: Friday, June 11, 2004 1:10 PM

Subject: your STSM visit

I, the undersigned, Pier Luigi BONORA, confirm that Lidia BENEÀ, worked in my institution on a short-term scientific mission in the frame of the COST Action 532, WG3 Tribochemistry, M1 Project, during the period from 19/04/2004 to 18/05/2004. The work was focused on:

i) electrochemical methods (cathodic polarisation and electrochemical impedance spectroscopy diagrams performed at cathodic potential) to study the influence of dispersed nanosized particles on the mechanism of nickel reduction;
ii) surface characterisation of composite coatings obtained by SEM and EDX;
iii) Preparation of 10 samples in a special shape for tribocorrosion tests. She worked very hard and the results obtained will be presented at the Annual Meeting of International Society of Electrochemistry (ISE), which will be held in Greece during 19-24 of September 2004. The title of paper will be:

Study of nanosized SiC particles co-deposition with nickel by electrochemical methods. with acknowledgment of COST 532 STSM visit.

We will continue our collaboration in the field of composite coatings.

P.L. Bonora

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Other comments (if any)

We should like to thank the COST Office for giving us the opportunity of these STSM visits. We can perform some special work with modern techniques at our partners from others countries (Italy, France etc.) which are not for the moment in Romania.

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