# Mechanical Properties of Composite Electrolytic Nickel Coatings Obtained by Pulsed Current

Dudkina V.V., Zabludovsky V.A., Shtapenko E.Ph.

*Dnepropetrovsk National University of Railway Transport named after academician V. Lazaryan, Dnepropetrovsk, Ukraine*

The electrolytic coatings based on nickel are widely used to protect metal surfaces from corrosion, mechanical damage, improve the strength characteristics and sliding strength of the products. In addressing the issue of improving the functional properties of electrolytic coatings the promising direction is to obtain nanocomposite materials with the use of ultrafine particles (UFP).

The deposition of composite coatings was carried out from aquosystem nickel plating with the adding up UFP particles of concentration 2 g/l by current rectangular impulse with the frequency of 50 Hz, the pulse relative duration from 2 to 50 and the average current density is 100 A/m$^2$. The microhardness of the coatings was measured on the microhardness tester PMT-3 at load indenter of 0.196 N.

The sample life service tests were conducted on friction machine with reciprocating samples in conditions of unlubricated friction. The electron microprobe analysis was made by using the electron-scan microscope JSM-64901LV (Japan).

The conducted researches showed that the structure and mechanical properties of the composite electrolytic nickel coating depend on the mode of electrodeposition, the contents and distribution of the co-deposition nanodiamond particles in matrix metal.

According to the spectral analysis results of composite coatings samples at increasing of current pulse relative duration from 2 to 50 and their invariable frequency is observed the increasing of particle content UFP in a covering from 17÷33 to 35÷43 of weight % and their more equal distribution in a covering that led to the formation of finely crystalline, more closely-packed coverings and defined the rising mechanical characteristics of the composite coatings. So the nickel coverings, deposited by means of direct current with density 100 A/m$^2$, in 5 hours of wearing process lose 10 % of the weight. At the pulse mode deposition with the frequency of 50 Hz and pulse relative duration equal 2, the coverings microhardness increases by 35-40 %, and wearing process makes 7 %. At increasing the current pulse relative duration from 2 to 50$^{th}$ the microhardness increases by 20-25 %, and wearing process decreases to 3 %.

Thus, the increasing of co-deposition particles UFP contents in the nickel covering received by means of pulse current allows forming composite electrolytic nickel coatings with increased microhardness and wearing resistance.