Nanostructured surfaces

Design and optimization of synergistic inhibitive compositions for the formation of corrosion-resistant nanostructured coatings

V.M. Ledovskykh[1], Yu.P. Vyshnevska[2,3], I.V. Brazhnyk[4], S.V. Levchenko[1]

[1] *National Aviation University. Kosmonavta Komarova Ave, 1, Kyiv-03058, Ukraine.*

[2] *National Technical University of Ukraine "Kyiv Polytechnic Institute". Peremohy Ave., 37, Kyiv-03056, Ukraine. E-mail: vishnevsk@ukr.net.*

[3] *Institute for Renewable Energy, Nat. Acad. of Sci. of Ukraine. Chervonogvardiyska str., 20A, Kyiv-02094, Ukraine.*

[4] *Gimasi SA Ukraine R&D Centre. Via L. Lavizzari, 18, Mendrisio-6850, Switzerland.*

A promising approach to development of the corrosion protection methods in various media is the design of new highly efficient inhibiting compositions that are characterized with the overadditivity effect of the components. The nature of the synergistic phenomena may be explained in terms of improving the structural parameters of the protective coating on the nano- and subnano scale. This effect is extremely increased in the case of mixtures of the inhibitors with different mechanism of action. The inhibitive mixtures that combine the oxide and salt passivation ($NaNO_2$ – Na_2SiO_3), oxide and adsorption passivation ($NaNO_2$ – amine) for protection of mild steel in neutral medium have been investigated. The synergistic inhibition effect of these mixtures can be attributed to the formation of nanoscale structures with 'close-packing' arrangement. In presence of $NaNO_2$ – Na_2SiO_3 protective layer is formed as a result of the oxide passivation (Fe_2O_3) and additional salt passivation with slightly soluble silicates of iron (II), while in the case of $NaNO_2$ – amine the adsorption of the amine ensures the deceleration of anodic reaction in a wide range of potential with minimum current of complete passivation. The formation of dense passivation film has been confirmed using SEM. Elemental composition is found to be in a good agreement with the concentration ratio of the mixture components in solution.

It was discovered, that synergistic phenomena in the case of complexing type inhibitors for the corrosion protection in acidic medium are mainly attributed to the refined complex geometry and alignment that result in improved microstructure of the protective layers. In presence of amino acids and guanidine derivatives, the complex conformations are found to have a significant influence on solubility of the mixed complexes and affect overall inhibitive efficiency. Determination of such regularities allows one to avoid the empirical approach to optimization of inhibiting compositions for a development of new surface engineering methods for obtaining the corrosion-resistant nanostructured coatings.