SYNTHESIS, CHARACTERIZATION AND ANTICORROSIVE PROPERTIES OF PSEUDO-BINARY OXIDE NANOMATERIALS

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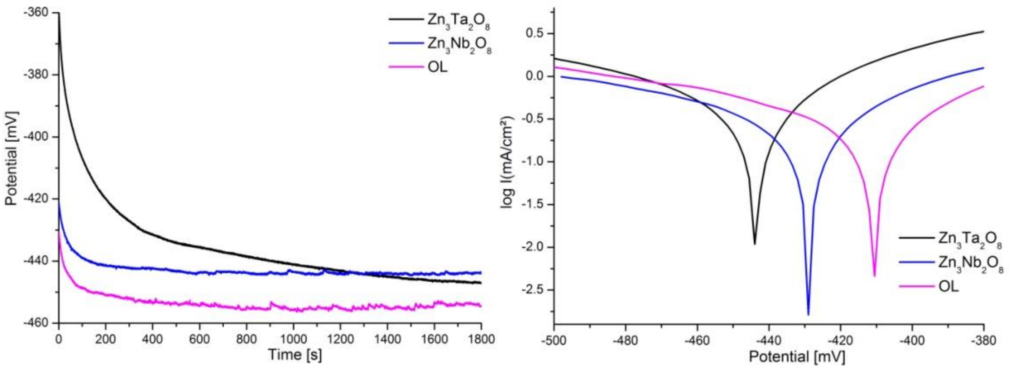
Abstract

This paper presents some results of the study regarding the corrosion inhibition properties evaluated in 0.1 M NaCl environment of drop casting deposited on steel, using $Zn_3Ta_2O_8$ and $Zn_3Nb_2O_8$ nanomaterials.
$Zn_3Ta_2O_8$ and $Zn_3Nb_2O_8$ nanomaterials were obtained by hydrothermal method. The starting materials used during the synthesis were: tantalum (V) oxide - Ta_2O_5(99.99%, Merck), niobium (V) oxide - Nb_2O_5 (99.99%, Merck) and zinc acetate dihydrate – $(CH_3COO)_2Zn$ x $2H_2O$ Merck, 99.5 %) while keeping the molar ratio at 1:3. The pH of the obtained mixtures was adjusted to 12 by using sodium hydroxide (NaOH) solution of 10 M concentration. The resulting suspensions were transferred into Teflon-lined stainless steel autoclaves and then these were introduced in an oven at 220 ^{0}C for 8 h long. The filling degree of the used autoclaves was set at 70%. The resulting white precipitates were filtrated, and then five times washed with distilled water and, finally, three times with ethylic alcohol. In the next stage, the precipitate was dried in an oven at 80 ^{0}C for 6 h [1-3].

The obtained materials were used for thin films depositions using the drop casting method. The depositions were realized on polished carbon steel electrode disks (10 mm diameter and 2 mm thick).
The surfaces of the thin films realized using the pseudo-binary oxides nanomaterials $Zn_3Ta_2O_8$ and $Zn_3Nb_2O_8$ on electrode steels were morphological and topographical investigated using the scanning electron microscopy (SEM – Model Inspect S) and the atomic force microscopy (AFM - ModelNanosurf$^@$ EasyScan 2 Advanced Research microscope) using the non-contact mode cantilever (scan size 2.3 µm x 2.3 µm).
From AFM measurements, according to equations from [4], were determined the topographical parameters S_a – the average roughness and S_q – the mean square root roughness for each drop casting deposition's surface on steel electrodes. The obtained values were calculated using the NanoSurf EasyScan 2 software.
The corrosion behaviour was studied using on Voltalab potentiostat Model PGZ 402 with single compartment three-electrode cell. Platinum wire was employed as counter electrode and the saturated calomel electrode (SCE) was the reference electrode. All potentials reported in this article were referenced to the standard hydrogen electrode (SHE). Bare and coated steel substrates were used as working electrodes. The potentiodynamic polarization curves were analyzed using VoltaMaster 4, v.7.09 software. This software performed the Tafel fitting and calculated the values of the corrosion potential (E_{corr}), corrosion current density (i_{corr}) and corrosion rate (v_{corr}). The measurements were performed by sweeping the potential between −700 and 100 mV, in 0.1 M NaCl electrolyte solution, at a scan rate (v) of 1 mV/s. The degree of the corrosion inhibition efficiency IE (%) has been calculated [5] for each drop casting deposition.



a b

Figure 1 a) Evolution of open circuit potential with time for investigated electrodes, in 0.1 mol / L NaCl saline solution; b) Tafel representation of polarization curves recorded in 0.1 mol / L NaCl saline solution

The anticorrosive properties of the coatings were evidenced by electrochemical measurements taken in 0.1 NaCl acidic media. For all the drop casting depositions consisting in pseudo-binary oxide materials on carbon steel electrodes a degree of the inhibition efficiency over 70% was obtained.

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References

[1] M. Bîrdeanu, A.-V. Bîrdeanu, A.S. Gruia, E. Fagadar-Cosma, C.N. Avram, J Alloy. Comp. 573 (2013) 53-57.

[2] M. Birdeanu, M. Vaida, F. Peter, E. Fagadar-Cosma, 21th International Symposium on Analytical and Environmental Problems", Szeged, Hungary, 2015

[3] M. Birdeanu, A.-V. Bîrdeanu, I. Popa, B. Taranu, F. Peter, I. Creanga, A. Palade, E. Fagadar-Cosma, Comparative research regarding corrosion protective effect of different sandwich type nanostructures obtained from porphyrins and pseudo-binary oxides by changing the deposition order, NANOCON 2014-6th International Conference on Nanomaterials, Nov 5th – 7th, Brno, Czech Republic, Conference ISI Proceedings, Ed. TANGER Ltd., Ostrava, Czech Republic, 2015, p. 262-268, ISBN 978-80-87294-53-6.

[4] V. Kapaklis, P. Poulopoulos, V. Karoutsos, Th. Manouras, C. Politis, Thin Solid Films, 2006, vol. 510, pp. 138.

[5] Z. Ahmad, Principles of Corrosion Engineering and Corrosion Control, Butterworth-Heinemann / IChem Series, Elsevier 2006.