UPSCALING OF PULSE ELECTRODEPOSITION PROCESS FOR THE PRODUCTION OF Ni-P/SiC NANOCOMPOSITE PROTECTIVE COATINGS

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ABSTRACT

Wear and corrosion of materials causes GDP losses of 3-4% and billions of Euros are spent annually on capital replacement and control methods for wear and corrosion infrastructure. In the protective coatings sector two main techniques dominate: hard chromium plating (HC) and thermal spray (TS), though both methods face serious environmental, authorization and hazard issues. Thus, alternatives to hard Cr have been extensively studied at lab scale from various scientific groups [1-4]. In the framework of EU's Horizon 2020 research and innovation programme "PROCETS" [5], Creative Nano's electroplating pilot line has been employed for the successful upscaling (120 L) of direct and pulse current plating processes, towards the development of low P Ni-P/SiC composite coatings with improved hardness and corrosion resistance. One of the test cases of the project involves the production of coated cylindrical steel rods. Before every plating experiment, the rods were subjected to a pre-treatment process including alkaline degreasing, anodic electrocleaning and acidic etching in order to properly clean and activate the substrate surface. During plating the electrolyte was circulated by utilizing a pump and an adjustable nozzles system placed at the bottom of the tank, so as to enhance the suspension of the particles, reduce their sedimentation and constantly replenish the cathodes with particles. Additionally, a specially designed rotation mechanism was employed for the rotation of the rods during the plating process, thus ensuring the homogeneous incorporation of SiC nanoparticles across the surface of the rods. The electrolyte contained 10 g/L 100 nm sized SiC nanoparticles and the applied current density varied from 0.5 to 2 A/dm^2. The coated parts were subjected to various characterization methods in order to evaluate their performance in terms of surface morphology, nanoparticle incorporation, microhardness, corrosion and wear resistance. SEM-EDS analysis revealed that the composite coatings exhibit stable P content at 4-6 % wt, while the corresponding SiC incorporation ranges from 4 to 9 % wt. Moreover, the samples showed hardness values about 900 HV, which increased up to 1200 HV after heat treatment at 300 °C for 1 h. Finally, the produced rods were subjected to real environment testing, exhibiting promising results.

REFERENCES

[1] Walsh FC, Ponce de Leon C. (2014). *Trans. IMF*, 92(2): 83-98.
[2] Roos JR, Celis JP, Fransaer J, Buelens C. (1990). *JOM*, 42(11): 60-63.
[3] Zoikis-Karathanasis A, Pavlatou EA, Spyrellis N. (2010). *J. Alloys Compd.,* 494(1-2):396-403.
[4] Wang Q, Callisti M, Kosanovic Milickovic T, Zoikis-Karathanasis A, Deligkiozi I, Polcar T. (2016). *Wear,* 356-357:86-93.
[5] http://www.procets.eu/