coatings on the surface of steel samples from a solution of 0.2 g/L Zr (IV) + 0.15 g/L (VI) + 0.1 g/L Mo (Vi) are temperature 30 °C and time 10 min.

The thickness of the oxide-zirconium coatings formed under these conditions was 64.72 nm, and the adhesion strength was 3.17 MPa/s. Tests showed that the developed nanocoatings met the requirements for adhesion layers for paint and varnish coatings (LCP) in terms of their protective ability, since the width of corrosion penetration from the notch in these cases did not exceed 2.0 mm after 240 h of testing. These coatings are not inferior to phosphate coatings in terms of protective characteristics. It should be noted that zirconium-containing coatings have the smallest thickness and specific gravity in comparison with other coatings. It was revealed that paintwork varnish with a zirconium-containing adhesive sublayer had a higher adhesion strength to the base compared to crystalline and amorphous phosphate and chromate coatings [7,10].

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References

1. Kerstnera, E.K.; Kunsta, S.R.; Beltramia, L.V.R.; Vega, M.R.O. Anticorrosive performance of commercial nanoceramic coatings on AISI 1010 steel. *Mater. Res.* **2014**, *17*, 1497–1506. [CrossRef]
2. Yi, A.; Li, W.; Du, J.; Mu, S. Preparation and properties of chrome-free colored Ti/Zr based conversion coating on aluminum alloy. *Appl. Surf. Sci.* **2012**, *258*, 5960–5964. [CrossRef]
3. Cui, C.; Wang, D.; Li, X.; Qu, F.; Xu, T. A room temperature pre-treatment process: Ce^{3+} doted ZrO_2. Nanofilm coated on the cold-rolled plate surface. *Adv. Mater. Res.* **2012**, *347*, 147–152.
4. Zhai, Y.; Zhao, Z.; Frankel, G.S.; Zimmerman, J.; Bryden, T.; Fristad, W. Surface Pretreatment Based on Dilute Hexafluorozirconic Acid. In Proceedings of the 2007 Three-Service Corrosion Conference, Denver, CO, USA, 3–6 December 2007; pp. 1–16.
5. Adhikaria, S.; Unocica, K.A.; Zhaia, Y.; Frankela, G.S.; Zimmermanb, J.; Fristad, W. Hexafluorozirconic acid based surface pretreatments: Characterization and performance assessment. *Electrochim. Acta.* **2011**, *56*, 1912–1924. [CrossRef]
6. Nela, J.T.; Plessisa, W.D.; Nhlabathia, T.N.; Pretoriusa, C.J.; Jansena, A.A.; Crouse, P.L. Reaction kinetics of the microwave enhanced digestion of zircon with ammonium acid fluoride. *J. Fluor. Chem.* **2011**, *132*, 258–262. [CrossRef]
7. Zhurinov, M.Z.; Statsyuk, V.N.; Fogel, L.A.; Bold, A.; Abrashov, A.A.; Kostiuk, A. Determination of the optimal deposition conditions oxide-zirconium coating on steel base. *Rasayan J. Chem.* **2019**, *12*, 1287–1293. [CrossRef]
8. Fedrizzi, L.; Rodriguez, F.J.; Rossi, S.; Deflorian, F.; Maggio, R.D. The use of electrochemical techniques to study the corrosion behaviour of organic coatings on steel pretreated with sol-gel zirconia films. *Electrochim. Acta* **2001**, *46*, 3715–3724. [CrossRef]
9. Dunham, B.; Chalk, D.D. Non-phosphate transition metal coatings. *Clean. Pretreat. Surf. Prep.* **2001**, *1*, 112–118.
10. Abrashov, A.A.; Grigoryan, N.S.; Vagramyan, T.A.; Meshalkin, V.P.; Kotel'nikova, A.V.; Gribanova, A.A. Protective adhesive zirconium oxide coatings. *Prot. Met. Phys. Chem. Surf.* **2016**, *52*, 1170–1174. [CrossRef]
11. Mohammadloo, H.E.; Sarabi, A.A. Titanium composite conversion coating formation on CRS in the presence of Mo and Ni ions: Electrochemical and microstructure characterizations. *Appl. Surf. Sci.* **2016**, *387*, 252–259. [CrossRef]
12. Shcram, T.; Goeminne, G.; Terryn, H.; Vanhools, W. Anticorrosive coating based on zirconium. *Inst. Met. Finish.* **1995**, *73*, 91–97.
13. Mohammadloo, H.E.; Sarabi, A.A.; Alvani, A.A.S.; Sameie, H.; Salimi, R. Nano-ceramic hexafluorozirconic acid based conversion thin film: Surface characterization and electrochemical study. *Surf. Coat. Technol.* **2012**, *206*, 4132–4139. [CrossRef]
14. Milosev, I.; Frankel, G.S. Review—Conversion coatings based on zirconium and/or titanium. *J. Electrochem. Soc.* **2018**, *165*, 127–144. [CrossRef]
15. Guan, Y.; Liu, J.; Yan, C. Novel Ti/Zr based non-chromium chemical conversion coating for the corrosion protection of electrogalvanized steel. *Int. J. Electrochem. Sci.* **2011**, *6*, 4853–4867.
16. Statsyuk, V.N.; Bold, A.; Zhurinov, M.Z.; Fogel, L.A.; Sassykova, L.R.; Vagramyan, T.A.; Abrashov, A.A. Using cyclic voltammetry to determine the protective ability of phosphate coatings. *Funct. Mater.* **2020**, *27*, 605–610.