REVIEW FROM DOMESTIC SCIENTIFIC CONSULTANT

on the dissertation of Daniel Mekonnen Zellele entitled "Electrochemical Synthesis and Functional Properties of Metal and Alloy-Based Composition Coatings," submitted for the degree of Doctor of Philosophy (PhD) under the educational program 8D07103 "Materials Science and Technology of New Materials."

The development of composite electrolytic coatings (CECs) is one of the relevant and topical areas of materials science. The principle of CEC fabrication is based on the formation of heterophase systems during the electrolysis process. By varying the electrodeposition conditions, it is possible to ensure a predetermined surface microrelief and, thus, purposefully control the functional properties of protective coatings.

It has been established that, despite the widespread application of CECs synthesized by the electrochemical composite method, available data on these coatings are either limited or contradictory. This primarily concerns studies of the mechanisms of surface strengthening, as well as the application of electrochemical methods for producing composite coatings with enhanced functional properties on metal surfaces.

As a result of the research conducted, the doctoral candidate D. Zellele developed and optimized electrodeposition techniques for composite coatings based on chromium, nickel, and cobalt using electrochemical methods. Techniques for synthesizing crystalline coatings of binary Ni–Cu and Co–V alloys with enhanced tribological, anticorrosion, and catalytic properties were mastered, including an investigation of the influence of deposition modes (direct current and pulsed current) on crystal size.

The doctoral candidate D. Zellele also mastered corrosion testing techniques for electrolytically deposited cobalt- and nickel-based binary alloys and independently carried out scanning electron microscopy (SEM), atomic force microscopy (AFM), and energy-dispersive X-ray spectroscopy (EDS) studies. The morphology of the synthesized chromium–graphene electrolytic coatings was determined for various temperatures and current densities, which manifested in the formation of different microstructures.

New suspension electrolytes of optimal composition were developed, enabling the production of Co–V-based CECs with improved physicochemical properties. D.M. Zellele determined the morphology of the synthesized Cr–C composite electrolytic coatings under the influence of temperature in the range of 288–333 K. This resulted in the formation of a nanocrystalline structure at deposition temperatures of 288–303 K and 316–320 K, and a cracked and microporous structure

at 301–305 K. The dissertation experimentally demonstrated that at a current density of 38.5–41.5 mA/cm², a uniform hemispheroidal morphology with minimal porosity and the highest structural integrity is formed. It was shown that the deposited Ni–Cu coatings exhibit a (111) texture and the absence of oxide phases, indicating a stable crystalline growth mechanism characteristic of the selected deposition parameters.

The results of the dissertation research have been published in 15 scientific publications, including international peer-reviewed high-ranking journals, and have been presented at international and national scientific conferences and seminars. Based on the results of the dissertation research, D.M. Zellele has three publications in journals with high impact factors (Q1 and Q2). All the objectives set in the dissertation research have been fully accomplished, and the research goal has been completely achieved. I consider that the dissertation of D.M. Zellele meets the established requirements for works submitted for the degree of Doctor of Philosophy (PhD). On the basis of the above, D.M. Zellele is recommended for public defense for the degree of Doctor of Philosophy (PhD) under the educational program 8D07103 "Materials Science and Technology of New Materials."

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