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Wear resistance of multilayer nanostructured coatings in 3% NaCl and 5% NaOH

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Statement of the Problem: Functional properties of single-layer and multicomponent coatings in different aggressive media are minimal. Recently, there has been a great interest to the possible use of multilayer coatings for increasing the wear and corrosive properties of cutting tools and friction pairs.

Purpose: The purpose of this study is to investigate the dependence of wear, corrosive, physical and mechanical properties of multilayer coatings on their structure, phase and elemental composition, and to develop multifunctional multilayer coatings and their optimal technology.

Methodology & Theoretical Orientation: Multi-layer coatings based on TiN, ZrN, Ti1-xAlxN, and TixZr1-xN layers were deposited by various methods: magnetron sputtering, CAE and the combination of these methods. The methodology of studying the phase and elemental composition, texture, microstructure of coatings, as well as the methodology of electrochemical, mechanical and wear tests are described in.

Findings: Multifunctional multilayer coatings with the synergistic effect of stoichiometric layers and technologies of their deposition have been developed. The common feature of all interleaved nanostructured layers is their high physical and mechanical properties. Individual functionality of layers: The layer with the maximum value of cubic phase, ZrN, exhibits the greatest anodic dissolution inhibition in 5% NaOH; two interleaved layers with the maximum value of cubic phases, ZrN and TiN, - the greatest corrosion resistance and protecting effect for tool steel and hard alloy in 3% NaCl and 5% NaOH and two interleaved layers Ti1-xAlxN and TixZr1-xN with maximum value of phases $Ti_3Al_2N_2$ and $TiZrN_2$, respectively - the greatest thermodynamic stability and wear resistance.

Conclusions & Significance: The achieved corrosion inhibition efficiency in 3% NaCl is over 2500 times, and in 5%NaOH - over 3000 times. The current inhibition in the passive state in 3% NaCl is 2500 times and in 5% NaOH -2000 times. The best collection of wear, physical and mechanical properties is f=0.2, H=36 GPa, E=358 GPa, We=76%.

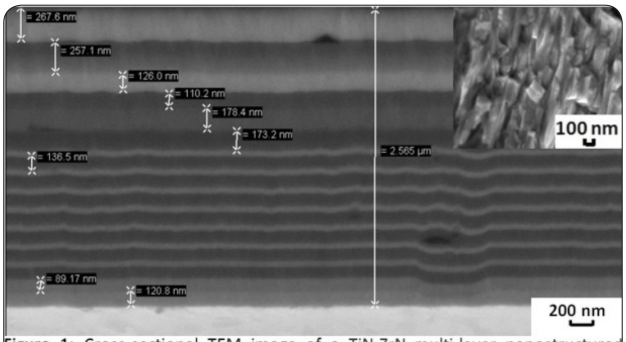

Figure 1: Cross-sectional TEM image of a TiN-ZrN multi-layer nanostructured coating with high corrosion resistance in 3% NaCl and 5% NaOH

Recent Publications:

1. Kameneva A, Guselnikova L and Soshina T (2011) An influence of a substrate voltage bias and temperature conditions on structure and phase modification in single-component ion-plasmas' films. e-Journal of Surface Science and Nanotechnology. 9:34-39.
2. Kameneva A (2013) Model of structural zones of the TiN and TiAlN coatings formed by the arc evaporation of metal in an active gas medium. Russian Journal of Non-Ferrous Metals. 54(6):541-547.

3. Kameneva A (2014) The influence of aluminum on the texture, microstructure, physical, mechanical and tribological properties of Ti1-xAlxN thin films. RJPBCS. 5(6):965-975.
4. Kameneva A (2015) The influence of TiN, ZrN and TixZr1-xN layers of anti-friction multi-layer coatings on corrosion resistance of hard alloy in sodium hydroxide solution. RJPBCS. 6(1):1381-1391.
5. Kameneva A and Karmanov V (2013) Physical and mechanical properties of the TixZr1-xN thin films. Journal of Alloys and Compounds. 546:20-27.

Biography

Anna L Kameneva has her expertise in the field of obtaining nanostructured multifunctional coatings with synergistic effect of layers for hardening and protecting cutting tools and friction pairs. Her structural models, showing the structure evolution depending on the main technological parameters, allow the development of multilayer coatings with a complex of wear, corrosive, thermodynamic, physical and mechanical properties. Her research focuses on the optimization of technology for the multilayer nanostructured coatings formed by cathodic arc evaporation, magnetron sputtering and the combination of these methods. The developed coatings are introduced in various industries.

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