CORRECTION OF THE DISTRIBUTION PROFILES OF THE INTENSITIES OF ELEMENTS CONSIDERING THE UNEVEN DISPERSION OF THE GLOW-DISCHARGE OPTICAL EMISSION SPECTROMETER FOR MULTILAYER COATINGS ANALYSIS

I.A. SHULEPOV[2], A. LOMYGIN[1], R.S. LAPTEV[1], E.B. KASHKAROV[1], M.S. SYRTANOV[1]

[1]National Research Tomsk Polytechnic University, Tomsk, Russian Federation
[2]Institute of Strength Physics and Materials Science, Siberian Branch of the Russian Academy of Sciences, Tomsk, Russian Federation

Thin films and coatings are used in various fields of technology, from microelectronics and optics to protective coatings from multiple influences. Optimization of the deposition processes and determination of coating destruction mechanisms are based on studies of the microstructure and chemical composition using electron microscopy, X-ray diffraction analysis and photoelectron spectroscopy [1]. However, in this case, in addition to technical problems associated with the deposition of a large number of layers, methodological problems also arise in-depth profiling due to physical and instrumental artefacts that accompany ion sputtering of ultrathin and thin multilayer coatings [2]. Thin-film analysis by depth profiling methods is based on surface erosion as a result of bombardment by particles with different energies, and the substance is continuously removed depending on the bombardment time. One of these methods is GD-OES [3].

This work aimed to model the dependence of the distribution profiles of the intensities of the elements, taking into account the non-uniformity of spraying.

The multilayer CrN/ZrN coating was deposited by magnetron sputtering onto a stainless steel substrate. The total thickness of the resulting coating was 17-18 microns. To analyse the chemical composition of the coatings and the distribution of the layers, a GD-Profiler 2 glow discharge spectrometer was used. When adjusting the profiles of the distribution of intensities of the luminescence of the elements, an exponential dependence was used. Auger spectroscopy was used to analyze the coatings quantitatively.

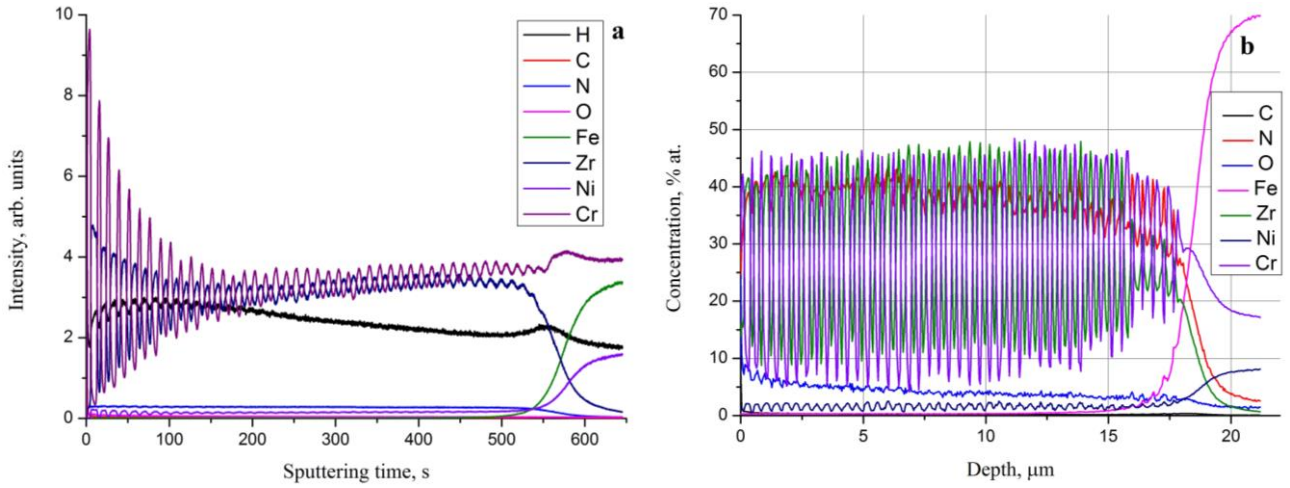

Fig.1. Distribution profiles of elements: a - initial profile, b - distribution profile corrected and recalculated to atomic concentrations.

As a result of this work, the possibility of eliminating from physical and instrumental artefacts was shown, the initial spectrum was corrected after taking into account the spraying unevenness. The luminescence intensities of the elements in atomic concentrations were also recounted to understand the quantitative chemical composition of the resulting CrN/ZrN coating.

REFERENCES

[1] Y. Y. Chang, C. P. Chang, D. Y. Wang, S. M. Yang, W. Wu, “High temperature oxidation resistance of CrAlSiN coatings synthesized by a cathodic arc deposition process”, Journal of Alloys and Compounds, vol. 461, no. 1-2, pp. 336-341, August 2008.

[2] A. B. Tolstoguzov, “Multilayer thin-film coatings based on chromium nitride and aluminum nitride: Comparative depth profiling by secondary ion mass spectrometry and glow-discharge optical emission spectrometry”, Journal of Analytical Chemistry, vol. 65, no. 13, pp. 1370-1376, December 2010.

[3] M. Nekhin, A. Kuznetsov, P. Shapon, “Glow discharge spectrometer PROFILER-2 is a powerful analytical tool for layer-by-layer analysis of materials”, Analytics, no. 4, pp. 34-43, May 2012.