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THE STRUCTURE AND MECHANICALP ROPERTIES OF IMPACT COATING BASED ON Zr-Re-N*

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In outer space, there is a continuous bombardment of the spacecraft surface by small solid particles which have a transverse size of about 0.1-100 microns, and move at high speeds of 5-50 km / sec. As a result, many small craters and scratches are formed on the surface of the optical elements, in particular the windows. With a sufficiently long stay in open space, a strong erosion of the glass surface occurs, which significantly worsens the characteristics of the windows. This leads to a change in the optical, electrical, mechanical, and other characteristics of optical elements [1], which affects the performance of a spacecraft as a whole.

One of the possible ways to protect the windows is to apply protective coatings on their surface, which have a high resistance to shock loads [1-2]. In this work, coatings based on Re-Zr-N obtained by pulsed magnetron deposition were used to protect glass elements of a spacecraft from mechanical damage arising from the impact of micrometeoroids. The analysis of the structure and the properties revealed that various contents of argon in the argon-nitrogen gas mixture during deposition had a significant effect on the microhardness of the coating and the adhesion between the coating and the substrate [3,4].

In this connection, the purpose of this work is to investigate the effect of the argon content in the argon-nitrogen gas mixture under pulsed magnetron deposition on the microstructure, phase composition, and the mechanical properties of the coatings on the basis of the Zr-Re-N system.

The results of studies of the microstructure, phase composition, physical and mechanical properties of the Zr-Re-N coatings with a thickness of 5 μm on quartz glass substrates produced by pulsed magnetron deposition are presented. The X-ray, high-resolution transmission and electron microscopy (HRTEM) as well as nanoindentation methods were used to investigate their phase configurations, nanostructures and mechanical behaviors in order to investigate their dependences on the argon content.

It was established the method of magnetron deposition, Zr-Re-N coatings on the surface of quartz glass have been obtained with a gradient structure close to the amorphous one. Depending on the amount of argon in the mixture of gases (nitrogen and argon), the degree of crystallinity of the coating changes. In addition, a change in the ratio of nitrogen and argon affects the elemental composition of the coating. The composition of the coating with an argon content of 80% is close to Re2-Zr-N and a coating with an argon content of 60% to Re1.4- Zr- N. The protective coatings of the Zr-Re-N system with an argon content of 80% have a higher hardness compared to these with 60 and 70% of argon in the gas mixture.

REFERENCES

[1] E. Lewin, D. Loch, A. Montagne et al., “Comparison of Al–Si–N nanocomposite coatings deposited by HIPIMS and DC magnetron sputtering,” Surf. Coat. Technol. Vol. 232, pp. 680–689, 2013.

[2] Sergeev V., Psakhie S., Chubik P., et al., “Magnetron sputtering of Si-Al-N nanocomposite coatings on quartz glasses for protection against impacts of high speed microparticles” Vacuum,” vol. 143. Pp. 454-457, 2017.

[3] N. Panich, P. Wangyao, S. Hannongbua, P. Sricharoenchai and Y. Sun, “Effect of argon-nitrogen mixing gas during magnetron sputtering on titanium interlayer deposition with tIb2 coatings on high speed steel, Rev. Adv. Mater. Sci. vol.16, pp.80-87, 2007.

[4] Y.H. Lu a,*, J.P. Wangb, Y.G. Shen, “Effect of N content on phase configuration, nanostructure and mechanical behaviors in Ti–Cx–Ny thin films”, Applied Surface Science, vol. 255, pp. 7858-7863, 2009.

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