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Examination of Ion-plasma Coatings Surface Layer by Means of X-Ray Diffraction

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Keywords – **X-Ray diffraction analysis, ion-plasma sprayed coatings, diffractometer.**

I. Introduction

This paper deals with a more profound analysis of physical-chemical processes occurring in ion-plasma sprayed coatings requires the investigation of coating phase structure - X-ray diffraction analysis.

II. Basic Research Results

Ion-plasma deposition of coatings has been developed at the modernized vacuum installation NNV6, 6-I. [1]. During the experimental studies two plasma sources have been used - an electric arc vaporizer (Ti) and magnetron (Al) [2].

One of the informative methods of examining crystal objects, including nanostructured materials, is an X-ray diffraction analysis based on the use of X-ray diffraction in the crystal lattice of coating material. [4]. Layer-by-layer investigation of objects is carried out with the help of "sliding ray" method. The method is based on decreasing penetration depth into the near-surface of a sample layer along with the decrease of x-ray sliding angle. This phenomenon is described in the Bragg law.

In the graphical interpretation of X-ray diffraction analysis (a diffractogram of investigated material), it is possible to observe X-ray reflections or peaks (diffractogram lines) of different intensity that appear sequentially, along with the change of X-ray sliding angle. Coordinates and height of such peaks characterize the basic properties of crystal lattice in the coating being investigated:

- crystal phases contained in a sample are determined (phase identification) from the angular position of diffractogram peaks and from their correlation by intensity by using special databases of X-ray lines;
- a quantitative analysis of crystal phases is carried out with account of peak height (intensity), which means that the concentration of each crystal phase in a sample is determined.
- the preferred crystallographic orientation of growth in the coating is determined from the correlation of intensity of X-ray lines in each peak, depending on the technological parameters of sputtering process;
- the total content of amorphous phases is determined from the intensity of non-linear background.

Diffractogram peaks have different width, depending on the size of crystalline particles, and can shift due to material microstresses. Regularities of width change and peak shift are used in analytical practice:

- the average size of crystalline particles in a certain phase is characterized by the width of peaks which increases as the size of crystalline particles diminishes;
- the increase of peak width also occurs as a result of a change in the interplanar spacing of crystal lattices caused by microstresses due to deformation during the cooling of coatings.

A diffractogram is obtained by using diffractometers. A schematic diagram of the diffractometer is shown in Figure 1.

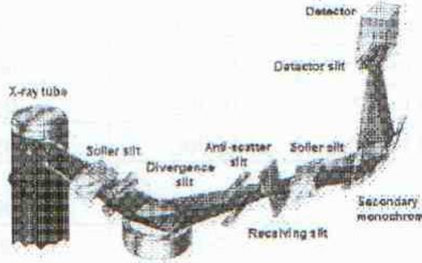

Fig. 1. Schematic diagram of diffractometer

A schematic diagram of most diffractometers includes a high-voltage electric source of X-rays with certain wavelength depending on X-ray source anode material. An electron beam generated by the source moves through the system of diaphragm slits and filters before and after it is reflected from the surface of investigated material. After its diffraction on the surface, X-radiation gets to the detector and is converted to an electric signal that enters the recording and analysis system.

III. Conclusions

Using the opportunities provided by the X-ray diffraction analysis as well as modern computer software and databases, it is possible to receive quite complete information about the process of sputtering and its basic characteristics that make it possible to forecast and optimize properties when developing new coatings. [3, 5].

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