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INVESTIGATION OF RESISTANCE TO HIGH-TEMPERATURE OXIDATION AND STABILITY OF THE STRUCTURAL-PHASE STATE OF CRALN COATINGS BY X-RAY DIFFRACTION ANALYSIS USING SYNCHROTRON RADIATION*

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The method of X-ray diffraction analysis using synchrotron radiation (Novosibirsk, Budker Institute of Nuclear Physics, Siberian Branch of the Russian Academy of Sciences) was used to study the resistance to high-temperature oxidation and the stability of the structural-phase state of ceramic coatings based on chromium and aluminum nitrides in the temperature range 30÷1300 °C. The source of synchrotron radiation was the VEPP-3 electron storage ring. The study was carried out using a high-temperature X-ray camera HTK-2000, a position-sensitive single-coordinate detector OD-3M-350, software - a program for processing measurement results Fityk v.1.3.1. The studies were carried out for the following experimental conditions: operating wavelength λ=0.172 nm, range of diffraction angles 2Θ: 28-59 degrees, sample heating rate 10 °C/min.

The processes of deposition of CrAlN coatings by the cathode-arc plasma-assisted method was carried out on an NNV6.6-I1 facility equipped with two electric arc evaporators with a cathode diameter of 80 mm and an additional “PINK” gas plasma source.

The results of studies of CrN/AlN coatings formed under conditions when metal plasma flows were mixed in the area of the substrate or were separated by a metal screen (layer-by-layer deposition) for heat resistance showed that these coatings behave similarly when heated in air. The critical temperatures differ slightly. The CrN/AlN coatings consist of chromium aluminum nitride, metallic aluminum is present. During heating, a change in the unit cell parameters of chromium-aluminum nitride and metallic aluminum is observed, indicating the mutual dissolution of the components; this process continues up to a temperature of ~725-730 °C, after which the reflections of aluminum disappear, and the reflections of chromium-aluminum nitride show only a shift due to thermal expansion. Chromium-aluminum nitride retains thermal stability up to a temperature of ~1110-1115 °C (~1075-1080 °C - with layer-by-layer deposition), after which the coating begins to oxidize, the reflections of chromium-aluminum nitride disappear at a temperature of ~1235-1240 °C (~1255-1260 °C with layer-by-layer spraying) (Fig. 1A and 1B).

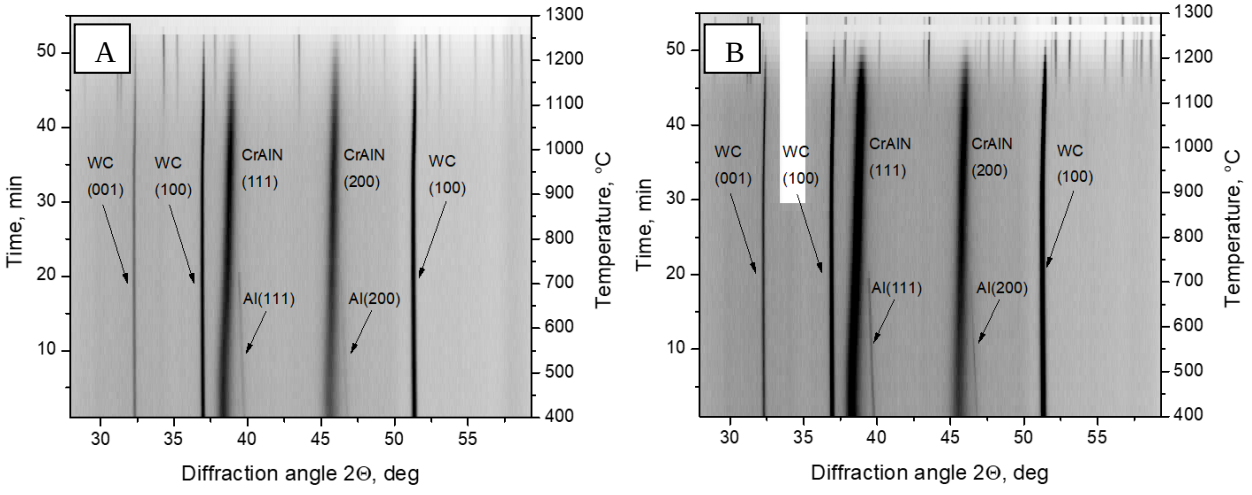

Fig.1. Full set of X-ray diffraction patterns of CrN/AlN (12rpm, screen - A) and CrN/AlN (12rpm, no screen - B) coatings during heating from room temperature to 1300 °C in air in projection view intensity on the plane "angle of diffraction - temperature"

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