

MOCVD OF Ir-Al₂O₃ PROTECTIVE COATINGS

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The goal of the present investigation was to obtain iridium and iridium-containing composite coatings with controllable structure to provide corrosion and/or erosion protection. One of the ways to change the structure of coatings is to introduce doping additives. In the present investigation, we studied many aspects of the deposition of composite Ir-Al₂O₃ coatings using iridium(III) and aluminium(III) acetylacetonates. To determine deposition conditions, a mass spectrometric investigation of the joint decomposition of the vapors of complexes in controllable atmosphere was performed.

It was shown that in vacuum the vapors of complexes decompose independently of components ratio of the mixture; in hydrogen, threshold decomposition temperature points decrease in comparison with those for individual compounds; in oxygen, the threshold temperatures of the decomposition of complexes decrease, too; along with this, we observed mutual effect of compounds on decomposition processes.

CVD processes were performed at atmospheric pressure; the variable parameters were: substrate temperature (320-450°C); temperatures of the two zones of evaporator (for Ir(acac)₃ 215-235°C; for Al(acac)₃ 145-185°C); carrier gas (Ar, flow rate of 3 and 24 l/h; H₂, flow rate 2,4 l/h); reagent gas flow rate (O₂), V_{ox} was varied from 0,1 to 1,8 l/h.

Iridium coatings with a mean thickness up to 5 μm were obtained in hydrogen atmosphere. Independently of deposition parameters, iridium coatings cracked all over and partially exfoliated off the substrate. Ir-Al₂O₃ coatings deposited in hydrogen have the layered structure. On the basis of XPS study we may describe the composition of the studied upper layers as two layers of metallic iridium separated by a rather complicated interface layer consisting of alumina, iridium oxide (or their compound) and most likely metallic iridium as well. The iridium layers in composite coatings obtained in the hydrogen atmosphere have mainly columnar structure.

Iridium coatings with a thickness up to 40 μm were obtained in the presence of oxygen. The analysis of SEM images (Figs. 1, 2) and X-ray diffraction analysis demonstrates that the decrease of the deposition temperature leads to obtaining a more perfect structure. Thick coatings deposited at 320°C in oxygen are composed of several layers with different structures (Fig. 2). Ir-Al₂O₃ composite coatings obtained by means of the joint decomposition of the vapor of precursors in the presence of oxygen have the most perfect compact structure (Fig. 3). One can conclude from the data of SEM and X-ray diffraction analysis that the introduction of Al₂O₃ as a doping additive into the iridium coating causes a substantial decrease of the crystallite size.

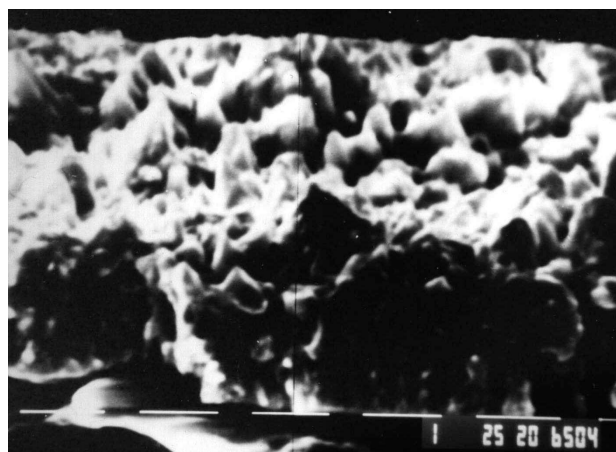


Figure 1. SEM image of the fracture and surface of Ir coating obtained at 340°C in the presence of oxygen.

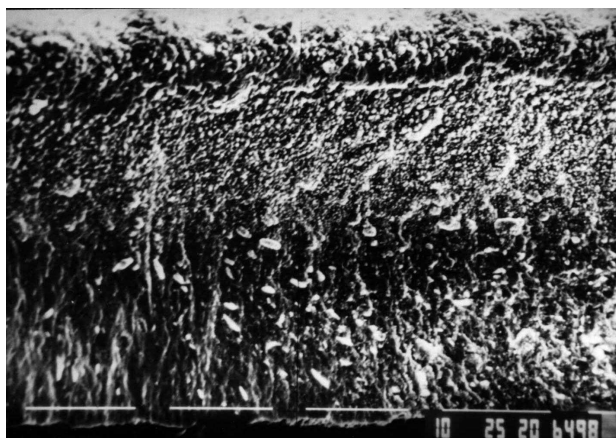


Figure 2. SEM image of the fracture of Ir coating obtained at 320°C in the presence of oxygen.

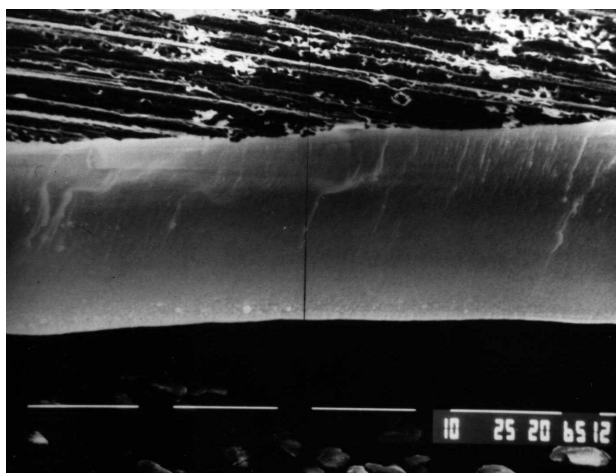


Figure 3. SEM image of the fracture of composite Ir-Al₂O₃ coating obtained by means of the joint decomposition of the vapor of precursors in the presence of oxygen at 320°C.

The conducted investigation allows us to purposefully change the parameters of CVD process in order to obtain iridium and iridium-alumina composite coatings of the required structure.