ON THE GENERATION OF BARRIER ANODIC OXIDE FILMS (AOF) WITH MESH STRUCTURE IN ALUMINUM

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According to their morphology, the anodic oxide films on aluminum are known to be subdivide into 2 types: the poreless barrier films, and porous films consisting of oxide cells looking like hexagonal prisms with a centered micropore.

Following aluminum anodizing in 0.05M citric acid solution and current density of 0.05 A/dm^2, we obtained mesh barrier AOF. Such films are formed when the samples are anodized immediately after electrochemical polishing, i.e. when the aluminum surface preserves the film generated by electrical polishing. The electron microscopic studies helped to find that said AOF specifically inherits the preceding film porous structure. During anodizing, the film growth takes place only in the oxide cell centers, where the protrusions are formed, without any considerable film thickening at the cell boundaries.

Similar unusual structure is formed on the aluminum surface by anodizing the samples with thin porous AOF (for instance, generated by oxalic acid) on their surfaces. Film growth occurs mainly in the cell centers (the micropore locations) and results in pillar-like protrusions, looking like hexagonal prisms and separated by the clear-cut channels (Figure 1). Similar pillar-like protrusions were previously obtained on the tantalum surface by tantalum-aluminum bi-layer composite anodizing in citric acid [1].

It should be noted that similar AOP cannot be obtained if the preceding oxide structures are removed from the aluminum surface before anodizing. In this case, the conventional poreless barrier films are formed.

The formation mechanism of such unusual structures becomes apparent after the study of aluminum surface structural composition at various processing stages. Thus, the film that was found at the aluminum surface following its polishing in the mixture of chromate, sulfate and phosphate acids, contained sulfur (SO_4^{-2}) and phosphorus (PO_4^{-3}), which are the film structural constituents. Accidentally, chromium was not found in the film, thus supporting Thomson's [2] conclusion on the selective mechanism of anion introduction to oxide layers. These structural ions are distributed in the film very non-uniformly. It is evident that the difference in chemical composition between the cell centers and their borders is the key phenomenon resulting in the generation of such unusual AOF structure during anodizing.

Boundary oxide electrolyte AOF Boundary oxide metal

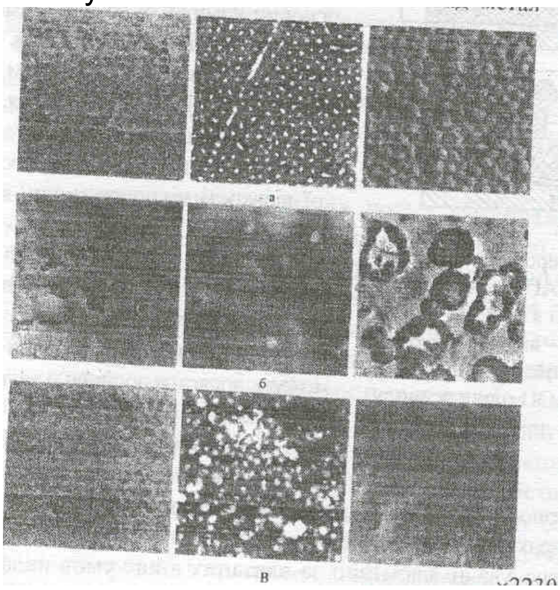

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Fig. 1 *Structure changes of porous AOF on aluminium during the reanodization in citric acid solution: a – initial state porous AOF; b – AOF (‹ 260 nm) after the reanodization of aluminium up to 250V; c – AOF (› 260 nm) after the reanodization of aluminium up to 250V.*

References

1. V.A. Sokolet al. Electron microscopic studies of anodizing of double-layer structures. *Dokl.AN BSSR* – V. 33, No. 10. - P. 891 - 894. (in Russ.)
2. G.E. Thompson et al. Anodic oxidation of aluminum/ Phil; Mag.1987.–V.55, №6. – P.651-665.