Anodization of Aluminum in Highly Viscous Phosphoric Acid. PART 2: Investigation of Anodic Oxide Formation and Dissolution Rates

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A novel self-sticking adhesive tape for the local anodization of aluminum that can be removed without residue after anodization was developed. The extremely high viscosity of the electrolyte used in the anodization tape is the main difference to conventional bath anodization in aqueous phosphoric acid. Through the application of a step-like voltage program with abrupt changes in the anodization voltage, sublayers within the porous part of the anodic oxide were formed and then examined using transmission electron microscopy (TEM). The sublayers enable an estimation of the oxide formation and dissolution rates of bath and tape anodization. Both rates depend on the anodization voltage. At the beginning of the anodization process, the oxide formation rates for bath anodization and tape anodization were very similar. At a voltage of 25 V, a formation rate of 0.9 nm s^{-1} was obtained for bath anodization, compared to 0.8 nm s^{-1} for tape anodization. However, the formation rate for the anodization tape slows down considerably in the later stages of anodization. This effect, which was not found for bath anodization, can be attributed to a local aging of the highly viscous electrolyte used for the anodization tape. Another special feature of the anodization tape is a very low rate of chemical oxide dissolution ($\leq 0.04 \text{ nm s}^{-1}$). In contrast, dissolution rates in the range of 0.1 to $\geq 0.2 \text{ nm s}^{-1}$ were found for bath anodization, which are typical for strongly dissolving electrolytes such as phosphoric acid.

Keywords: aluminum, tape anodization, phosphorous acid, porous anodic oxide layer, oxide formation and dissolution rate

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