

## Effect of the anodization conditions on the growth and volume expansion of porous alumina films in malonic acid electrolyte

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Abstract

Galvanostatic formation of nanoporous anodic films on aluminum was performed in 0.6 mol·dm<sup>-3</sup> malonic acid electrolyte over a wide current density range in order to define the relationship between the anodizing behavior, oxide growth, dissolution and volume expansion of the oxide. The volume expansion and aluminum dissolution increase with raising the current density, the latter indicating an increasing potential difference across the electrolyte/barrier-layer interface. The same potential difference promotes dissociation of the acid molecules and incorporation of electrolyte-derived species into the film. The increase of volume expansion occurs in three phases, resulting from the two dissociation steps of malonic acid and from the change in the oxide growth mechanism at higher current densities. Infrared spectroscopy showed an enhanced presence of OH in films formed at higher current densities, indicating that lower coordination of aluminum as well as anion incorporation contributes to volume expansion of the oxide. The current appeared to be 100% ionic in the interval of 5–100 mA·cm<sup>-2</sup>, while being about 10% electronic beyond this range. At higher current densities a self-localizing mechanism concentrates the ionic current to a smaller, spot-like area that moves continuously along the sample consuming steadily the whole metal thickness under the spot and thus forming a porous anodic film of highly self-ordered morphology, without physical imperfections. The volume expansion factor of the oxide becomes independent of the anodization current density under these conditions.

Keywords

Anodization; Porous anodic alumina; Malonic acid; Volume expansion factor; Current efficiency; Self-localized anodizing

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