A thermodynamic understanding of horizontal pores formation in anodized doped aluminum with alloying elements

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PII: S1572-6657(18)30666-0
DOI: doi:10.1016/j.jelechem.2018.10.006
Reference: JEAC 12646

To appear in: *Journal of Electroanalytical Chemistry*

Received date: 8 August 2018
Revised date: 1 October 2018
Accepted date: 3 October 2018

Please cite this article as: A.M. Mebed, Alaa M. Abd-Elnaiem , A thermodynamic understanding of horizontal pores formation in anodized doped aluminum with alloying elements. Jeac (2018), doi:10.1016/j.jelechem.2018.10.006

A thermodynamic understanding of horizontal pores formation in anodized doped aluminum with alloying elements

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ABSTRACT

Although there is a plenty of work in many publications concerning three-dimensional (3D) pore formation by an anodization process, though no definitive conclusion has been given to the mechanism of its formation. Accordingly, the process of 3D architecture is still a subject of considerable debate. The aim of the present study is to extend the previous findings, bringing out the relationship between different components such as the thermodynamic role of the precipitations mechanism in dilute aluminum (Al) alloy at the alloy/film interface, film thickness, anodizing potential and the resulting porous anodic alumina (PAA) film morphology. Dislocation movement following Orowan mechanism and its role in enriching layer formation is connected for the first time in explaining the formation of the enriched layer. Consequently, the precise disruption of the 3D morphologies within the anodic films is developed. The distributions of copper (Cu) spices in the alloy as well as within the enriched layer on the Alloy/film surface are carefully investigated and explained using different experimental techniques. In addition, the Oxygen generation is explored. The present study is designed to reveal the influences of impurities on the PAA architecture. It has the advantage of being a direct explanation for the mechanism of the defect in the PAA and its incorporation into the anodic film throughout the anodic film. Moreover, a reliable explanation for current density oscillation is explored. That help to gain further understanding of this phenomenon to control PAA structure in thermodynamically similar alloys. Based on the present study, free Cu atoms in solid solution are swept driven by vacancies according to Orowan interface during anodization forming an enriched ~2 nm layer of Cu just beneath the anodic film. The copper is not significantly incorporated into the anodic film before the formation of θ' precipitates in a thick film; whereas of thickness less than 500nm, the Cu atom migrates outward forming patterned precipitates rest at the surface for the thin film. The concentration of θ' precipitates is calculated and found ~ 9×10^{15} m^{-3}. Accordingly, the Cu incorporation into the anodic film and 3D structure mechanism are correctly explored.