Colored Layers on Zirconium: Preparation and Characterization

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AC polarization of Zr in aqueous Na_2SO_4 results in the formation of bright, uniform, well-defined colors. The coloration is due to thin-layer light interference, also referred to as iridescence. A wide spectrum of colors is accomplished by varying the oxide thickness that is tuned by varying the applied AC voltage (V_{AC}/V), the polarization time (t_{pol}), the electrolyte's pH and concentration.

Optical microscopy and scanning electron microscopy (SEM) were used to evaluate the morphology of the films. The data demonstrate that the films are compact and do not reveal fractures or cracks. The surface and near-surface region chemical composition of these colored passive layers on Zr was examined using X-ray photoelectron spectroscopy (XPS) coupled with Ar-ion depth profiling. The thickness of these oxide films was determined using XPS depth profiles and SEM cross-section analysis. The data show that their thickness ($d/\mu m$) varies from ~0.8 to ~ 1.3 μm depending on the experimental conditions.

We also performed an electrochemical analysis of these layers by recording polarization curves and determining various parameters such as corrosion potential and current-density (E_{corr}, i_{corr}), critical potential and current-density (E_{cr}, i_{cr}), current density in the passive region (i_{pass}) and the transition from the passive region to trans-passive one. Such obtained and analyzed polarization curves demonstrate that the thicker the oxide surface, the more stable the passive layer is. We also analyzed the performance of these oxide-covered in the potential region of the hydrogen and oxygen evolution reactions.

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References

1. G. Jerkiewicz, H. Strzelecki, A. Wieckowski, *Langmuir*, 12 (1996) 1005-1010.
2. S. Hrapovic, G. Vatankhah, B. L. Luan, G. Jerkiewicz, in Proceedings of the Symposium on *Environmental Degradation of Materials and Corrosion Control in Metals*, Eds. M. Elboujdaini, E. Ghali, MetSoc, CIM, Montreal (1999).
3. S. Hrapovic, B. L. Luan, M. D'Amours, G. Vatankhah, and G. Jerkiewicz; *Langmuir*; 2001, 17 (10), pp. 3051-3060.