
Abstract

In this work, the influence of the preparation method on the structural and electrochemical properties of the RuO₂/Ta₂O₅ system was investigated. A systematic investigation of the structural, morphological, electrochemical, and electrocatalytic properties for O₂ evolution from acidic solutions was carried out using anodes of nominal composition Ti/RuO₂-Ta₂O₅ (Ru:Ta – 10 ≤ Ru ≤ 90 step 10 atom %), prepared by the polymeric precursor method (PPM), in which the solutions were prepared by mixing citric acid (Merck) in Ethylene glycol (Merck) with RuCl₃.xH₂O (Aldrich) and Ta(OC₂H₅)₅ (ACROS). Anodes of nominal composition Ti/RuO₂-Ta₂O₅ (Ru:Ta = 30:70; 50:50 and 80:20 atom %) were also prepared by the standard method (SM) from the appropriate molar ratios of the precursors mixtures (RuCl₃.xH₂O and TaCl₅ - Aldrich) in alcoholic solutions (isopropanol – Aldrich). For both methods, thermal decomposition was carried out under at 450 °C for 1 h - O₂-flux of 5 dm³ min⁻¹. Analyses of the composition and the morphology of the oxide layer were done before and after the accelerated life tests (ALT), through EDX (Energy dispersive X-rays) and SEM (Scanning electron microscopy), respectively. SEM results gave evidence of typical mud-flat-cracking morphology for the majority of the films. EDX analyses even after total deactivation showed that there is reduction in the content of Ru in the coating. Structure data were obtained by XRD (X-rays diffraction), and they showed the rutile-type structure for RuO₂ and the orthorhombic one for Ta₂O₅.

Cyclic voltammograms of this system were registered in acidic solutions (0.5 mol dm⁻³ of H₂SO₄). The observed peak was attributed to the solid-state redox transition of Ru(III)/Ru(IV). At low overpotentials, the Tafel slope (b) displayed average values of 40 mV. The electrocatalytic activity showed a strong dependence on the content of RuO₂ in the film. The stability of the electrodes was evaluated by ALT, performed at 0.5 mol dm⁻³ in aqueous H₂SO₄ (750 mA cm⁻² and T = 80 °C). Results showed a performance that is 100 % better than that obtained with the electrodes prepared by SM. In the presence of an organic compound (Ethanol and Acetaldehyde), the VC and Tafel results showed that electrodes prepared by PPM are electrocatalytically better than those obtained by SM. The studies on Ethanol and Acetaldehyde oxidation showed high reactivity for Acid Acetic and CO₂ formation at low Ethanol concentration (5 mmol dm⁻³). On the other hand, the increase in Ethanol concentration (15 – 1000 mmol dm⁻³) favors Acetaldehyde formation (1 – 3 %) and, therefore, the formation of Acid Acetic and CO₂ is lower.