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Optimizing RuO_x–TiO_2 composite anodes for enhanced durability in electrochemical water treatments

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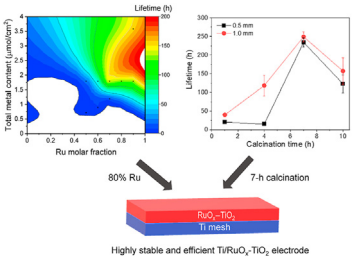
GRAPHICAL ABSTRACT



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ABSTRACT

Metal oxide anode electrocatalysts are important for an effective removal of contaminants and the enhancement of electrode durability in the electrochemical oxidation process. Herein, we report the enhanced lifetime of RuO_x–TiO_2 composite anodes that was achieved by optimizing the fabrication conditions (e.g., the Ru mole fraction, total metal content, and calcination time). The electrode durability was assessed through accelerated service lifetime tests conducted under harsh environmental conditions, by using 3.4% NaCl and 1.0 A/cm^2. The electrochemical characteristics of the anodes prepared with metal oxides having different compositions were evaluated using cyclic voltammetry, electrochemical impedance spectroscopy, and X-ray analyses. We noticed that, the larger the Ru mole fraction, the more durable were the electrodes. The RuO_x–TiO_2 electrodes were found to be highly stable when the Ru mole fraction was >0.7. The $0.8RuO_x$–$0.2TiO_2$ electrode was selected as the one with the most appropriate composition, considering both its stability and contaminant treatability. The electrodes that underwent a 7-h calcination (between 1 and 10 h) showed the longest lifetime under the tested conditions, because of the formation of a stable Ru oxide structure (i.e., RuO_3) and a lower resistance to charge transfer. The electrode deactivation mechanism that occurred due to the dissolution of active catalysts over time was evidenced by an impedance analysis of the electrode itself and surface elemental mapping.

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1. Introduction

Metal oxide electrodes have attracted much attention to the

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