Metal Oxides Series

Series Editor
Ghenadii Korotcenkov

Advances in Metal Oxides and Their Composites for Emerging Applications

Editor
Sagar D. Delekar

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Nanostructured WO_{3-x} based advanced supercapacitors for sustainable energy applications

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6.1 Introduction

The rapid advancements in portable electronics and electric vehicles have created a demand for highly efficient electrochemical energy storage devices (Gao et al., 2013; Lokhande et al., 2019). Owing to their fast charging/discharging rates and superior energy densities, supercapacitors are regarded as the emerging high-efficiency energy storage systems with great potential for commercial application. Supercapacitors can store energy using two mechanisms, that is, (1) electrical double-layer capacitors (EDLCs) and (2) pseudocapacitors (Naik et al., 2020). EDLC involves reversible adsorption of ions at the electrode−electrolyte interface and produces low specific capacitance, such as in the case of carbon-based EDLCs (You et al., 2018). The second charge storage mechanism is by Faradaic charge transfer process involving reversible redox reactions and can be classified as pseudocapacitors (Fleischmann et al., 2020). Transition metal oxides exhibit pseudocapacitive behavior. For instance, due to its high theoretical and practically achievable capacitance, ruthenium oxide is the most widely explored pseudocapacitive material. However, its toxicity, along with its high cost, prevents its widespread practical applicability (Shinde & Jun, 2020). Many alternative transition metal oxides and conducting polymers such as manganese oxide, vanadium oxide, iron oxides, cobalt oxide, nickel oxide, tungsten oxides, polypyrrole, polyaniline, etc. (S et al., 2020) have been investigated for their charge storage properties. Among these, tungsten oxide is relatively promising due to its ability to switch between the oxidation state from +6 to +5 during electrochemical reactions, low cost, and environmentally friendly nature (Salkar et al., 2019).

The chemistry of tungsten and its investigation dates back to the late 1700, that is more than two centuries ago, when Carl Wilhelm Scheele discovered that tungstic acid could be made from scheelite (Smeaton, 1986). Later in 1783, Juan José Elhuyar and Fausto Elhuyar found an acid produced from wolframite and successfully isolated tungsten from it and have been credited for its discovery (Schufle, 1975). Since then, much research has been focused on tungsten and its compounds. WO_3 is also recognized as a candidate for several other applications such as photocatalysis, gas sensing, electrochromic, dye-sensitized solar cells, electrocatalysis,

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