Metal Oxides Series

Series Editor
Ghenadii Korotcenkov

Advances in Metal Oxides and Their Composites for Emerging Applications

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Sagar D. Delekar

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Metal oxide nanomaterials for organic photovoltaic applications

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7.1 Introduction

The continuous increase in world's population, together with the substantial development of industry, has brought about imperious demand for increased energy consumption. At present, most of the energy production is made from the combustion of fuels, such as oil, natural gas, and coal. However, the depletion of fossil resources, the commensurate increase in noxious gas emissions, and the other associated environmental pollutions have put forward an urgent demand for developing sustainable energy technologies. Among all of the renewable energy technologies, including hydro, solar, wind, geothermal heat, and biomass, photovoltaic (PV) technology that converts solar energy into electricity is the most promising strategy for sustainable energy supply (Bai & Zhou, 2014).

Organic-based photovoltaics (OPVs) have attracted increasing attention in recent years, and efficiencies exceeding 8% have recently been confirmed. These low-cost, lightweight, and mechanically flexible devices offer unique advantages and opportunities currently unavailable with crystalline silicon technology. Progress in the field of OPV has been achieved in part due to the incorporation of transition metal oxides. These offer a wide range of optical and electronic properties, making them applicable in OPV in many capacities. Transparent electrodes can be made from doped metal oxides. The high intrinsic charge carrier mobility of many undoped metal oxides makes them attractive as active materials and charge collectors. Metal oxides can increase the charge selectivity of the electrodes due to the energetic positioning of their valence and conduction bands (VBs and CBs) (Gershon, 2011). A promising and rapidly developing low-cost PV system is based on organic semiconducting polymers. These can be dissolved and coated onto many different surfaces via low-temperature techniques such as roll-to-roll processing semiconducting materials (Sun & Sariciftci, 2017). These have excellent charge transport properties and can be tuned in various ways through the introduction of dopants, the generation of nanostructures, or modification of their surfaces. Owing to the wide range of properties that these offer both optically and electronically, transition metal oxides can play many different roles within a "hybrid" organic/inorganic PV device. Organic molecular and polymeric semiconductors can form

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