p-type oxide semiconductors as hole collectors in dye-sensitized solid-state solar cells

J Bandara and J P Yasomanee

Institute of Fundamental Studies, Hantana Road, Kandy, Sri Lanka

E-mail: jayasundera@yahoo.com and jayasund@ifs.ac.lk

Received 7 August 2006, in final form 12 October 2006
Published 21 November 2006
Online at stacks.iop.org/SST/22/20

Abstract

Oxide semiconductors with p-type conductivity were found to be good candidates to be used as hole collectors in dye sensitized solid-state solar cells (DSSC). In this paper, a delofossite p-type $CuAlO_2$ semiconductor was synthesized by a hydrothermal method and its properties were investigated as a hole collector in DSSC. The valence band (VB) and conduction band (CB) positions of $CuAlO_2$ were appropriate to be used as the hole conductor in DSSC. Solar cells constructed with TiO_2/Ru dye/$CuAlO_2$ deliver $I_{sc} = 0.08$ mA cm^{-2} and $V_{oc} = 525$ mV. The particle size of $CuAlO_2$ prepared by the hydrothermal method was ~300–500 nm and the large $CuAlO_2$ particle penetrates weakly into the pores of a nanocrystalline matrix resulting in the weak interaction of the dye and hole collector, which was found to be one of the reasons for the poor solar cell performance of the solar cell constructed with $CuAlO_2$ as the hole collector. Bigger particle size and poor p-type conductivity are found to be the major limiting factors of $CuAlO_2$ as a hole collector. The solar cell performances of electrodes constructed with TiO_2/Ru dye/NiO are also discussed.