INSTITUTE OF PHYSICS PUBLISHING SEMICONDUCTOR SCIENCE AND TECHNOLOGY

Semicond. Sci. Technol. **20** (2005) 1127–1131 doi:10.1088/0268-1242/20/11/005

Photoluminescence study of CdTe/CdS solar cells grown from a source with Cu residual impurity

L Ghimpu[1], V V Ursaki[2], T Potlog[1] and I M Tiginyanu[2]

[1] Department of Physics, Moldova State University, MD-2009 Chisinau, Moldova
[2] Laboratory of Low Dimensional Semiconductor Structures, Institute of Applied Physics, Academy of Sciences of Moldova, MD-2028 Chisinau, Moldova

Received 21 April 2005, in final form 6 September 2005
Published 26 September 2005
Online at stacks.iop.org/SST/20/1127

Abstract

Three photoluminescence (PL) bands centred at 1.30, 1.35 and 1.45 eV have been observed in the PL spectrum of CdTe/CdS thin film solar cells grown by close space sublimation (CSS) techniques from a source with Cu residual impurity. The bands at 1.30 and 1.45 eV were found to be independent of the technological conditions of the CSS process, while the intensity of the band at 1.35 eV proved to increase with the increase of the source temperature and the decrease of the substrate temperature. This PL band is suggested to correspond to donor-Cu_{Cd} defects related to the incorporation in the CdTe film of the impurity from the source. The other two bands are associated with defects whose formation does not depend upon the technological processes applied, the band at 1.45 eV being attributed to a V_{Cd}–Cl_{Te} defect.

1. Introduction

CdTe/CdS heterojunction is one of the main candidates for large area, low cost commercial photovoltaic systems. It can be deposited in a cost-effective manner over large areas using close space sublimation (CSS) techniques. It is known that a post-growth treatment involving deposition of $CdCl_2$ and annealing in air at 400 °C increases the photovoltaic efficiency of the junction by approximately one order of magnitude [1–4]. The stability issues are now of prime importance for future implementation of thin-film CdTe solar cells.

Because of the high electron affinity of CdTe, a highly doped p^+-type back surface is required to improve the Ohmic characteristics of back contacts. p^+-type doping has been effectively achieved through the incorporation of Cu from the back contact as an intentional dopant. Although p^+-type doping is beneficial to cell performance, the long-term cell stability is often compromised. The diffusion of Cu from the back contact represents the most suspected source of instability for CdTe/CdS solar cells. Another reason of contamination by Cu during the CSS process is the content of the residual Cu impurity in the source material.

Photoluminescence is a powerful non-destructive approach commonly used for the purpose of characterizing semiconductors. Photoluminescence [5] and cathodoluminescence [6] have been previously used to study Cu-related stability issues in CdS/CdTe solar cells.

In this paper we investigate by means of photoluminescence the impact of technological conditions of the CSS process upon the incorporation of Cu into the CdTe/CdS heterojunction from a source containing the residual Cu impurity. Optimum technological conditions assuring minimum contamination of the heterojunction are found.

2. Experimental details

CdS/CdTe thin heterojunction solar cells were fabricated on glass substrates covered by a SnO_2 layer with a sheet resistivity of about 10 Ω/□. The SnO_2 layer served as a transparent front contact to the CdS layer. Both CdS and CdTe layers were deposited by the CSS method. The CdTe source contained Cu as the main residual impurity at a level of 1×10^{19} cm^{-3}. Different heterojunctions were fabricated at various source and substrate temperatures as specified in tables 1 and 2. The CdS layer with the resistivity of 2–3 Ω cm and transparency of 90% was 0.6 μm thick. After the CdTe layer was deposited, the structures were held in a $CdCl_2$:H_2O saturated

 © 2005 IOP Publishing Ltd Printed in the UK