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In-situ XRD study of alloyed $Cu_2ZnSnSe_4$-$CuInSe_2$ thin films for solar cells

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Abstract

We investigate the growth of $Cu_2ZnSnSe_4$-$CuInSe_2$ (CZTISe) thin films using a 2-stage (Cu-rich / Cu-free) co-evaporation process under simultaneous application of in-situ angle dispersive X-ray diffraction (XRD). In-situ XRD allows monitoring the phase formation during preparation. A variation of the content of indium in CZTISe leads to a change in the lattice constant. Single phase CZTISe is formed in a wide range, while at high In contents a phase separation is detected. Because of different thermal expansion coefficients, the X-ray diffraction peaks of ZnSe and CZTISe can be distinguished at elevated substrate temperatures. The formation of ZnSe appears to be inhibited even for low indium content. In-situ XRD shows no detectable sign for the formation of ZnSe. First solar cells of CZTISe have been prepared and show comparable performance to CZTSe.

Keywords: CZTSe, co-evaporation, in-situ XRD, CZTSe-CISe alloy

1. Introduction

In recent years quaternary kesterite absorber layers $Cu_2ZnSnSe_4$ (CZTSe) and Cu_2ZnSnS_4 (CZTS) have become a topic of high interest for thin film solar cells. Since these materials contain the earth abundant metals Zn and Sn, the kesterites are promising for large scale production of solar cells regarding cost

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