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Journal:	*Journal of Materials Science & Technology*
Manuscript ID	Draft
Manuscript Type:	Research Article
Date Submitted by the Author:	n/a
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Keywords:	CIGS, thin film solar cell, Defects, Composition, depth profiling, depth inhomogeneity
Speciality:	Characterization, Defect Analyses, Microanalysis, X-Ray Analyses, Thin Films

In-depth inhomogeneities in CIGS solar cells: Identifying regions for performance limitations by PIXE and RBS

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Abstract

When considering materials to be used as active layers of solar cells, an important parameter to be considered is elemental composition, which should be homogeneous and heavily controlled in order to decrease recombination defects, increasing thus the cell electrical performance. Ion beam analytical techniques are quite suitable to determine the thickness and composition of such active layers. Furthermore, if these techniques are performed using a nuclear microprobe, lateral and in-depth inhomogeneities can be clearly observed from 2D maps. In many cases, composition variations can be detected from the classical 2D maps obtained from the PIXE spectra. In this work, it is shown a proof-of-concept of how the in-depth variations can also be studied when considering the 2D maps reconstructed from the RBS spectra. These variations are not visible, or barely distinguishable, in the standard 2D-PIXE maps. These elemental variations can be related to: i) layer composition, ii) layer thicknesses variations, iii) substrate roughness, iv) other processing problems. Examples obtained on Cu(In,Ga)Se_2 based cells are presented and discussed. In this sense, the combination of ion beam analytical techniques can be a competitive and an alternative method to those more used and established techniques such as X-ray fluorescence.

Keywords: CIGS, thin film solar cell, defects, composition, depth profiling, depth inhomogeneity