CIS and CIGS Thin Films for Low-Cost Solar Cells

A. Ihlal\textsuperscript{1}, K. Bouabid\textsuperscript{1}, D. Soubane\textsuperscript{1}, M. Nya\textsuperscript{1}, O. Ait-Taleb-Ali\textsuperscript{1}, Y. Amira\textsuperscript{1}, A. Outzourhit\textsuperscript{2} and G. Nouet\textsuperscript{3}.

\textsuperscript{1}Laboratoire Matériaux et Energies Renouvelables (LMER), Faculté des Sciences, Hay Dakhla, Agadir, Marocco
\textsuperscript{2}Laboratoire de Physique des Solides et des Couches Minces (LPSCM), Département de Physique, Faculté des Sciences Semlalia, Marrakech, Marocco
\textsuperscript{3}Structure des Interfaces et Fonctionnalité des Couches Minces (SIFCOM), Ensicaen, Caen, France

1. Introduction

Copper and Indium disulphide or diselenide (CIS) and their alloys with Gallium (CIGS) have the requisite optoelectronic properties (high optical absorption coefficient, favourable bandgaps, suitable resistivities etc.) for photovoltaic (PV) applications. Moreover, polycrystalline CIS and CIGS solar cells outperform their monocrystalline counterparts. A variety of techniques were used in the preparation of these materials. The best cell efficiencies (around 20\%) were obtained on materials prepared with the co-evaporation of elements technique [1-3]. However, vacuum deposition processes are complex and expensive. Non vacuum processes offer an attractive alternative technique. In this contribution, we report some results on CIS and CIGS thin films prepared by a non vacuum process, i.e., one step electro-deposition.

2. Results and discussion

CuIn(Ga)Se\textsubscript{2} thin films were deposited on Mo coated glass adopting potentiostatic electrochemical method. The complete method is described in our previous work [4-6]. The electrolyte bath consisted of CuSO\textsubscript{4} (2.5 – 3.5 mM), In\textsubscript{2}(SO\textsubscript{4})\textsubscript{3} ( 2 - 3.5 mM) and SeO\textsubscript{2} (5 mM). For CIGS thin film deposition, Ga\textsubscript{2}(SO\textsubscript{4})\textsubscript{3} (0-2.5 mM) was used for Ga grading. Citric acid (C\textsubscript{6}H\textsubscript{8}O\textsubscript{7}, H\textsubscript{2}O), with a concentration between 0.1 and 0.3 M, was used as a complexing agent.

Fig. 1 shows the typical DRX spectra of the deposited and annealed film at 400°C. The well-known chalcopyrite structure is obtained upon annealing at 400°C with the preferential orientation in the (112) plane. The SEM micrograph (Fig. 2) shows the surface morphology of the sample annealed at 400°C in vacuum. The film consists of a compact morphology and homogeneous grains. The size of the grains is less than 1 µm. The optical absorption coefficient of our film exceeds 10\textsuperscript{4} cm\textsuperscript{-1}.

The resistivity of our films was adjusted around 10 Ω\textcdot cm by appropriate heat treatments. The characteristics of our samples match those measured on high vacuum processed films with significant advantages in capital costs.

3. Conclusion

In this study, we have demonstrated that non vacuum method (i.e., electro-deposition) could be used for the growth of good quality CIS and CIGS thin films. Thus, electro-deposition is an interesting and cost effective technique for the preparation of
good quality CIS films for low cost photovoltaic conversion.

Acknowledgments

This work was partially supported by the CNRST/CNRS cooperation program (Chimie 05/06).

References


