Selenium Chemistry Modifications of CIGS Surfaces After Various Wet Etching. High Resolution XPS Studies of Buried Interface CIGS/CdS.

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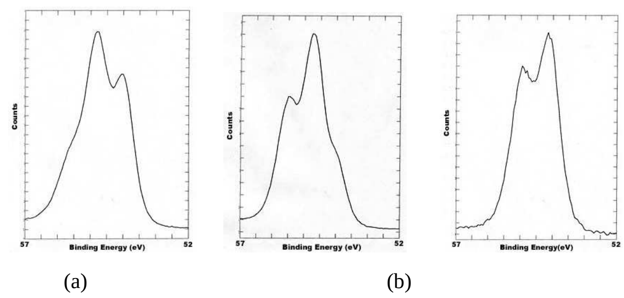
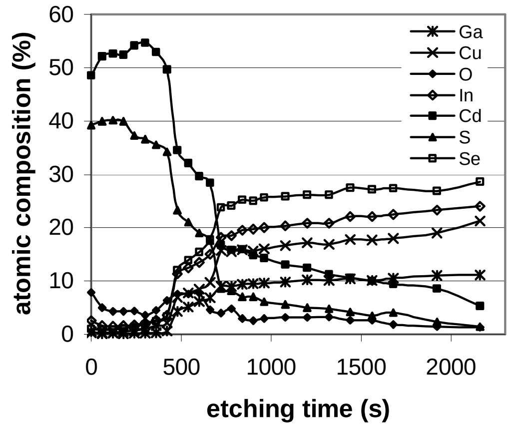
Although Cu(In,Ga)Se_2 is a technologically important material for thin film photovoltaic devices, the control of the superficial /interfacial chemistry is always an opened question. This point is however known to be crucial to improvement of devices.
The main question is to know if the control of CIGS/ CdS interface depends essentially of the last chemical treatment (i.e. CdS deposition in NH_3 environment par Chemical Bath Deposition) or rather of CIGS initial state surface.
In the present work, chemistry of co-evaporated CIGS surfaces submitted or not to various chemical treatments was investigated by high resolution XPS. The surface analysis allowed us to compare the surface composition with the bulk one as a function of the treatments.
Among all the XPS signals, the Se_{3d} core level is probably the most interesting probe to provide a fine XPS characterization of the CIGS surface before CdS or other layer deposition were performed. Moreover, any modification of this signal at a buried interface can be used as a probe to follow a chemical reactivity of interface during CdS growth. In this work, we present a detailed study of the evolution of Se signal, at CIGS surface but too at the CIGS/CdS interface.
CIGS surface treatments were performed using (i) acidic solutions (HCl and H_2SO_4) (ii) basic solution (NH_3) and (iii) aqueous bromide solution. Concerning points (i) and (ii), a part of XPS results were already published elsewhere [1]. We have shown that H_2SO_4 chemical treatment leads to formation of elementary Se on CIGS surface, and HCl or NH_3 treatments lead to elimination of surface oxides (In and Ga). Concerning bromide etch, a Se° film was formed on the CIGS surface that could be completely removed by KCN treatment, leaving a specular surface [2].
We will study essentially the CIGS/ CdS interface elaborate with these chemical treatments and discuss problems of nucleation and growth of CdS layer on well defined CIGS surfaces. We will discuss also about presence of impurities (C and O) in the CdS layer.
The surface composition analysis and concentration profiles will be presented. The discussion about the Se chemistry will be also compared to the results obtained on CdSe surface for which Se° layer can be obtained and removed using different chemical treatments.



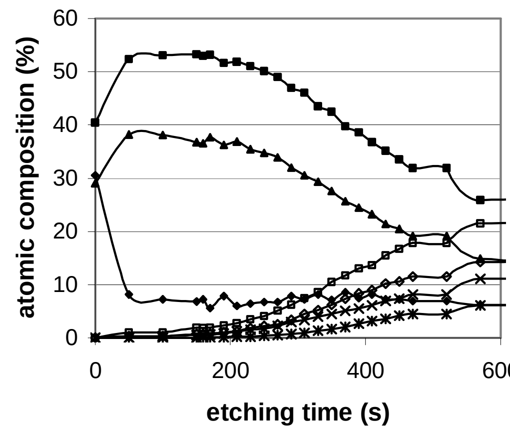
(a) (b)

(c)

Fig. 1: Binding energy of Se 3d core level for a CIGS surface as grown (a), after Br etch (b) and after Br+KCN etch (c).



(a)



(b)

Fig. 2: XPS composition profiles of CIGS/CdS structures. (a) CIGS/CdS and (b) CIGS/ammonia 1.5 M dipping 12 hours/CdS.

[1] B. Canava, J. Vigneron, A. Etcheberry, J.F. Guillemoles, D. Guimard, D. Lincot, S. Ould Saad, Z. Djebbour, D. Mencaraglia, *Thin Solid Films* 2002, in press.
[2] B. Canava, J. Vigneron, A. Etcheberry, J.F. Guillemoles, D. Lincot, in ICTMC 13 conference proceedings, in press.