Investigation of glass/ITO/Cu(In,Ga)S_2/CdS/window devices for back-wall illumination applications : influence of the absorber thickness

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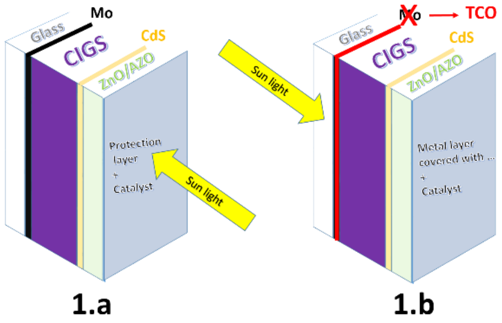
Wide bandgap Cu(In,Ga)S_2-based devices are among the most promising structures that can be used as photocathode for CO_2 reduction application. Decent results were achieved already by implementing the standardly used structure schemed in Fig.1a. However, in that configuration the sun light has to cross the electrolyte and the catalyst layer, yielding optical losses and long-term operation issues. To overcome them, the most relevant option consists in shining the device from the glass side, which additionally offers large scope of front side metal covering and thereby catalyst grafting. On the one hand, despite intensive works few decades before, superstrate configuration has never been successfully performing with CIGS absorbers. On the other hand, by substituting Mo back contact with a transparent conductive oxide, it appears possible to implement a so-called 'back-wall illumination' configuration (see Fig.1b). Furthermore, this approach is sound regarding other applications like 4T tandem.

Beyond the above-mentioned applied goals, this topic opens new rooms for basic investigations in fields related to photovoltaics, like among others solid-state physics and chemistry, optics and thin film growth. In fact, this approach yields several arising questionings as follows:

- What should be the thickness and characteristics of the absorber layer to achieve optimal V_{oc} and J_{sc} with back-wall illumination? Is it necessary that photons reach the space charge region since the diffusion length of carriers in these thin film based devices is rather short? Is it necessary to photo-excite the CdS buffer layer?
- Do we need to passivate the TCO/absorber interface?
- What optical losses induce the glass/TCO substrate? What are the rooms for improvements?

These question marks fit those resulting from our recent investigations on back-wall shined structures based on Glass/ITO/Cu(In,Ga)S_2/CdS/window stacks. In fact, as first parameter we have studied the influence of the thickness of the absorber. The devices fabricated without specific optimization show efficiencies with front illumination of about 10 % (800 mV, 19 mA/cm²), independently of the absorber thickness between 0.6 µm and 1.5 µm; note that the performance of the cells are limited by rather low fill factors (60%), probably due to non-optimized ITO/CIGS interface. Amongst other interesting results, we observe the best $J_{sc.BW}$, *ie.* while shining light from the rear side of the device, is achieved with the thinnest absorber (see Fig.2), probably due to low diffusion length of photo-generated carriers. Also very interesting is the evolution of the $V_{oc.BW}$ of the devices shined from the back side (see Fig.2); this latter continuously decreases with increasing(decreasing) film thickness($J_{sc.BW}$). These latter results seem to follow the school-books equations of photovoltaic solar cells, which is unusual enough in the field of CIGS thin film based devices to be emphasized here! Further astonishing results of these investigations will be presented and discussed during the JNPV conference.



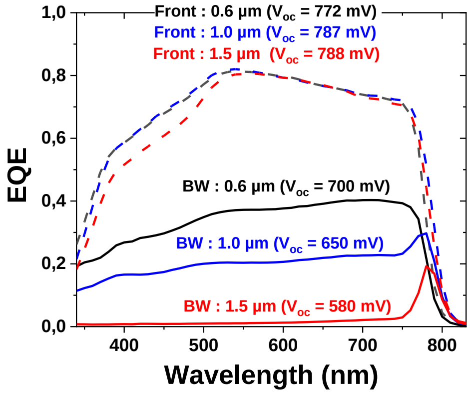


Figure 1 **Figure 2**

This was supported by the French National Agency projet PECALO (Dispositif photoélectrochimiques tandem pour la réduction du dioxyde de carbone et l'oxydation des alcools) grant no. Projet-ANR-20-CE05-0019.