High efficiency solar cells based on coevaporated $CuIn_{0.7}Ga_{0.3}S_2$ films: the revival of a too early forsaken material ?

N. Barreau(1), A. Thomere (1,2,3), R. Bodeux (2), M.T. Caldes (1), C. Guillot-Deudon (1), A. Crossay (3), V.D. Cammilleri (3), L. Assmann (1), N. Stephant, A. Lafond (1), D. Lincot (3)

Université de Nantes, CNRS, Institut des Matériaux Jean Rouxel, IMN, F-44000 Nantes, France
EDF R&D, 18, Boulevard Thomas Gobert , 91120, Palaiseau, France
Institut Photovoltaïque d'Ile de France (IPVF), 18 Boulevard Thomas Golbert, 91120 Palaiseau, France

Solar cells based on $Cu(In,Ga)Se_2$ (CIGSe) thin films have reached record efficiency close to 23 %; these outstanding performance result from more than three decades of academic and technological developments. However, so far the highest device efficiencies were achieved with CIGSe absorbers whose bandgap (ie. absorption threshold) ranges between 1.1 and 1.2 eV. For wider bandgap, meaning with higher gallium content, the performance of the devices drastically decrease which is clearly a bottleneck for the application such as top cell in tandem solar cells with c-Si. Wide bandgap (ie. E_g>1.5 eV) can be achived by partial or complete substitution of sulfur for selenium, leading to $Cu(In,Ga)(Se,S)_2$ materials.

The present contribution deals with sulfur based $Cu(In,Ga)S_2$ films and related solar cells. The investigated $CuIn_{0.7}Ga_{0.3}S_2$ layers were grown by coevaporation following a so-called 3-stage process. This approach offers the control of several process parameters which directly impact the characteristics of the resulting layers, thus cells performance. In particular, a possible route to control the relative distribution of group III elements (i.e. GGI) throughout the films will be presented, and the impact it has on device peroformance. Up to date, the best efficiency we have achieved with the standard structure (SLG/Mo/CIGS/CdS/ZnO/AZO/grids/ARC) is above 14 % (V_{oc}: 930 mV; J_{sc} : 21.2 mA/cm² ; FF: 0.72), with an absorber bandgap of 1.6 eV. This result opens many rooms for further improvement; they will also be presented and discussed during the congress.