New insights on light trapping for ultrathin CIGSe solar cells

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Abstract:

In the past decade, reducing the thickness of the CIGSe absorber layer in CIGSe-based solar cells has been identified as a key issue to reduce the Indium consumption and thus increase the competitiveness of CIGSe [1]. The typical thickness of a CIGSe layer is 2500 nm. Previous studies showed a degradation of the parameters of the cells when reducing the absorber thickness [2], [3] and improvements are therefore needed to increase the efficiency of very thin and ultrathin CIGSe absorber solar cells. In a previous study [4], we showed that it was possible to maintain a high efficiency in 400 nm solar cells by replacing the original Molybdenum back contact by a more reflective Gold back contact, which allowed to efficiently reflect the incident light that has not been absorbed during the first pass through the CIGSe. We used an innovative approach based on chemical etching of the CIGSe layer to reduce its thickness without degrading the material’s properties, and a lift-off of the CIGSe absorber to process the back contact at low temperature. In this study, this technique is used on ultrathin absorbers solar cells down to 100nm - 200 nm; at this scale, a flat metallic mirror is not sufficient anymore to efficiently trap the light in the CIGSe. A lambertian back scattering reflector is used lead to a significant increase of the path of light through the CIGSe by lambertian diffusion at the back side of the solar cell. Numerical simulations show a great potential for ultrathin absorber solar cells down to 100 nm [5]. A proof of concept device is realized and optically characterized; the experimental results are compared and discussed regarding the simulations. A major increase of the light absorption in the ultrathin CIGSe layer is observed with the lambertian back reflector layer, offering interesting perspectives for further development of 100 nm – 200 nm CIGSe absorber solar cells. Numerical simulations of a novel periodic structure based on surface plasmon resonance is also presented for application to ultrathin absorbers down to less than 100 nm thickness [6].

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