TRANSPARENT CONDUCTING OXIDE ELECTRODES REQUIREMENTS FOR HIGH EFFICIENCY MICROMORPH SOLAR CELLS

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Abstract

The requirements for a micromorph tandem cell front transparent conductive oxide (TCO) are multiple. This essential layer needs a high transparency, excellent conduction, strong light scattering into silicon and good surface morphology for the subsequent growth of silicon cells. These parameters are all linked and trade-offs have to be found for optimal layer. The optimum combination, taking into account current achievable materials properties, is still unclear. Concerning transparency, we study here the impact of free carrier absorption (FCA) on the photogenerated current by using first doped and non-intentionally-doped zinc oxide (ZnO). Then, Bi-layers made of flat indium tin oxide (ITO) under various thicknesses of rough ZnO allow a study of the haze influence alone. It is shown that FCA induces drastic current losses in the infra-red part of the spectrum, and haze increase enhances the cell response in the infra-red part up to a certain limit of grain size. Surface feature sizes above 0.4µm appear to be useless for haze increase purpose at the ZnO/Si interface. By using an optimized 2µm thick LPCVD ZnO, micromorph cells showing 13.7% initial efficiency, with a total current of 27.7 mA/cm2 could be obtained with 240nm and 2.8µm of top and bottom cell thicknesses.

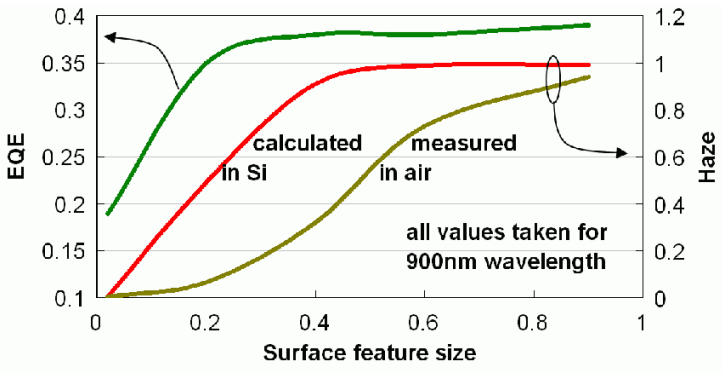

Figure 1 : Right axis: Haze in transmission measured in air and calculated in silicon for 900nm wavelength incident light for various thicknesses of LPCVD ZnO front electrodes as a function of the typical size of their surface features. Left axis: EQE value at the same wavelength of micromorph cells grown on the same LPCVD front electrodes.