Characterisation of CdS|CdTe Heterojunctions by Photocurrent Spectroscopy and Electrolyte Electroreflectance/absorbance Spectroscopy (EEA/EER)

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CdTe|CdS solar cells are fabricated by electrodeposition of CdTe on n-CdS|SnO_2(F) substrates. The as-deposited CdTe is n-type, and type conversion is achieved by annealing in air. In this work, the early stages of junction formation were studied using photocurrent spectroscopy and electrolyte electroreflectance/absorbance spectroscopy. Thin films (0.02 - 2.0 μm) of CdTe were electrodeposited from an acidic electrolyte containing a high concentration of Cd^{2+} and a low concentration of TeO_2 using chemically prepared CdS layers on fluorine-doped tin oxide coated glass as substrates. Characterisation of the as-deposited and thermally annealed CdTe|CdS heterostructures by photocurrent spectroscopy was carried out using transparent stabilising electrolyte contacts (1.0 M Na_2SO_3), which allowed illumination from the CdTe or CdS (glass) sides. The same electrolyte was used for electrolyte electroabsorption and electroreflectance spectroscopy (EEA/EER). Comparison of the photocurrent spectra for the two illumination directions allowed detection of type conversion and junction formation arising from heat treatment. The as-deposited CdTe films were n-type, and heat treatment at 415^{o}C resulted in conversion to p-type with formation of a heterojunction with the CdS. In the thinnest structures studied, photocurrent spectroscopy showed that the CdS film remained photoactive after heat treatment, and a clear CdS response could also be seen in the electroabsorbance spectra. Heat treatment of CdS|CdTe structures with thicker CdTe films (> 0.2 μm) resulted in a formation of a photo-inactive CdS layer, which gave rise to the well-known loss of photoresponse in the blue that is characteristic of CdS|CdTe solar cells. Electrolyte electroabsorbance and electroreflectance measurements showed that annealing changed the band gap of the CdTe, and this is attributed to$CdTe_{1-x}S_x$ alloy formation (x = 0.05 - 0.07).

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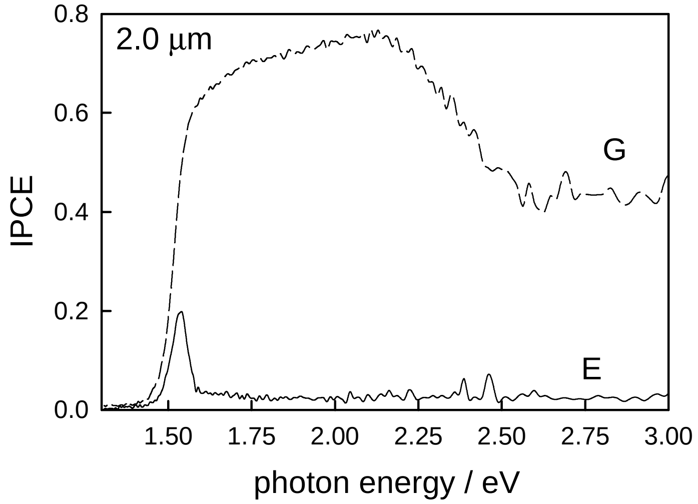
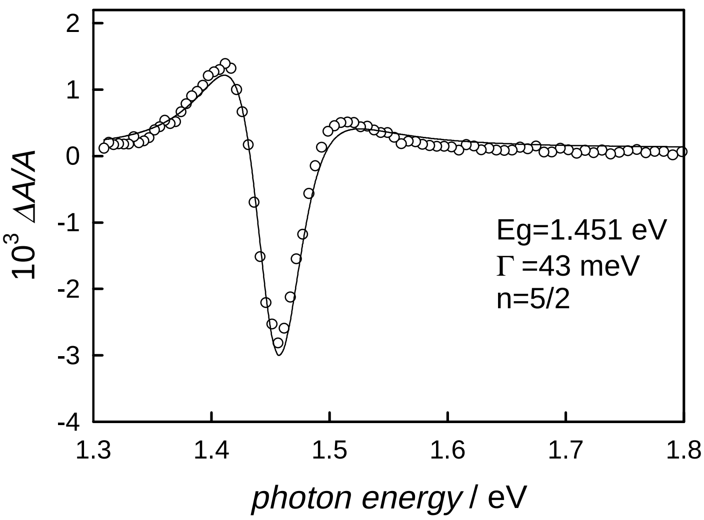
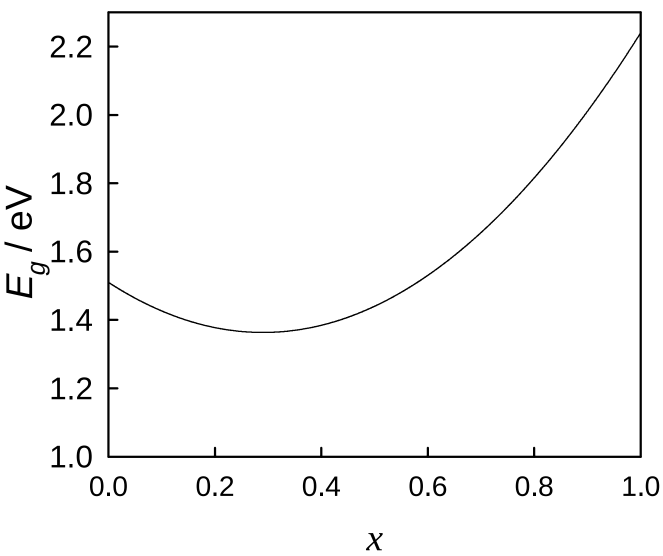


Corrected photocurrent action spectra for heat-treated 2.0 μm CdTe|CdS. E – illumination from the electrolyte side. G – illumination from the glass side. Potential 0 V vs. SCE. Electrolyte 1.0 M Na_2SO_3.



Example of fitting of EEA spectra in the CdTe region. The sample is a heat-treated 0.20 μm thick film. The small value of the broadening parameter Γ shows that the film is structurally and compositionally homogeneous. The low value of the bandgap indicates sulfur alloying.



The relationship between bandgap and composition for $CdTe_{1-x}S_x$