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## Morphology of Very Rough Interface and Compositional Profile of CdS/Cu(In,Ga)Se<sub>2</sub> Heterojunctions Studied by X-ray Fluorescence

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Interface morphology and compositional profile in a series of CdS/Cu(In,Ga)Se<sub>2</sub> (CIGS) heterojunctions have been investigated using the technique of angular dependence of x-ray fluorescence (ADXRF). In this system, the average interfacial roughness is very high and it exceeds the nominal thickness of CdS film (~ 400 Å). A new method based on density profile analysis has been worked out to account for the large interfacial roughness. This technique allows a possibility for *nondestructive* characterization of the concentration profile of both CdS and Cu(In,Ga)Se<sub>2</sub> layers as well as an estimate of the effective roughness parameters in this material system.

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**References:** S. Kim, Y.L. Soo, G. Kioseoglou, Y. H. Kao, K. Ramanathan, and S. K. Deb, "Compositional Intermixing at CdS/Cu(In,Ga)Se<sub>2</sub> Rough Interface Studied by X-ray Fluorescence", *J. Appl. Phys.* **91**, 6416-6422.

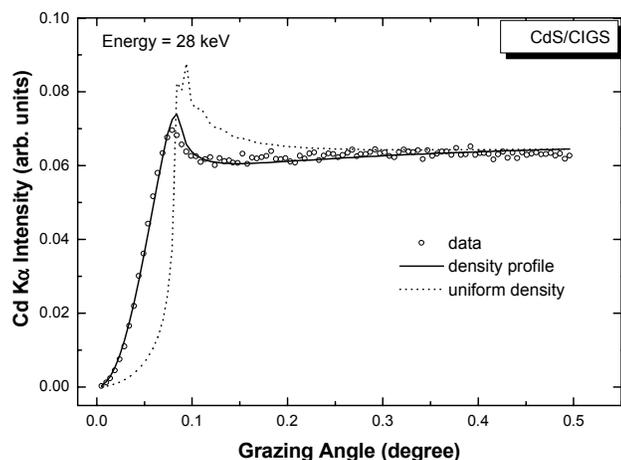


Fig. 1. Comparison of two different models with ADXRF data for the CdS/CIGS heterojunctions. A uniform CdS model (dotted line) cannot explain the fluorescence observation while a new model based on error functions for both density and concentration profiles is in good agreement with the experimental results.

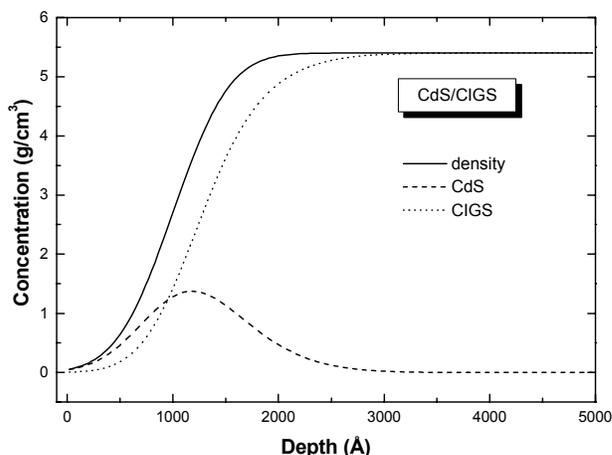


Fig.2. Density and concentration profiles determined for the CdS/CIGS junctions. An effective roughness  $\sigma_{\text{eff}}$  (about 450 Å) and a distribution length of CdS (about 1200Å) are obtained from this plot.