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Optical properties of ultrathin CIGS films studied by spectroscopic ellipsometry assisted by chemical engineering

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抄録 (Abstract)
CIGS (Cu(In1-x,Gax)Se2) based devices are very efficient for photovoltaic conversion. A non-destructive optical study of CIGS is an important challenge as for evaluation of the material quality, and for device modeling. Spectroscopic Ellipsometry (SE) is well adapted for a quantitative characterization only if the handicaps of the roughness limitation, the oxidized surface, or the compositional gradient are minimized. For this SE study, ungraded and thin CIGS samples are prepared with GGI (x) ratio (=[Ga]/([Ga]+[In])) ranging from 0.15 to 0.60. Thanks to chemical engineering based on acidic bromine solution etching and/or HCl de-oxidation, the SE experiments are performed on flattened surfaces, and also, on as grown de-oxidized samples. Using assumptions based on XPS, AFM and SEM complementary characterizations, we give proof of oxide free flattening surfaces and chemical homogeneity in depth. Using these observations, the SE data are modeled on the basis of a three layer model using an Adachi/Tauc-Lorentz formula for the CIGS dispersion. The optical gap values are determined in good agreement with the x ratio measured by the other characterization techniques. SE is able to well estimate the thickness and roughness variations on each sample. Furthermore, the CIGS optical constant extracted on such reference flat surfaces are then applied to the as grown-de-oxidized surfaces, enabling to describe the SE data obtained on rougher surfaces. A complete consistency of the proposed model is shown as well as the capability of SE to be sensitive to the chemistry of the surface. © 2016 Elsevier B.V.

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