Determination of illumination independent parameters of CIGS solar cells

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CIGS photovoltaic cells have great potential in indoor photovoltaic applications but have been poorly studied in the past [Virtuani2004], mainly due to the low parallel resistance of standard structures optimized for outdoor conditions. Indeed, the rough CdS/CIGS interface, the presence of grains in the absorber, and the copper rich CIGS phase tend to favor shunting pathways [Williams2015]. In this case, the strong contribution of the current that shunts the diode dominates under weak lighting conditions and is detrimental to the open-circuit voltage, which decreases proportionally to the photocurrent.

Here we present the thorough analysis of the IV characteristics of several CIGS solar cells, with different gallium and copper contents, measured as a function of the irradiance, from one sun down to low illumination conditions (~0.15 W/m^2). We use the classical one-diode model, with parallel and series resistances, combined with a collection term [Merten1998, Sun2016], and assume that the photogenerated current is proportional to the irradiance. We show that a single set of parameters, independent on the irradiance as a first approximation, allows a good fitting of all IV curves over an illumination range covering more than 3 decades. The evaluation of the electrical parameters for all the devices vs the gallium and copper concentrations is crucial for determining the optimum alloy composition of efficient indoor CIGS cells.

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