Optimization of the shunt resistance of $Cu(In,Ga)Se_2$ cells for indoor applications

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With the rise of Internet of Things (IoT), a sustainable and efficient power source for electronic devices, such as indoor photovoltaics, is essential [Bouclé2023]. Copper poor and gallium rich CIGS photovoltaic cells, marked by a high parallel resistance, hold promise for these applications, yet they have not received thorough exploration in the past [Virtuani2004].

Our research presents an extended analysis of the I-V electrical characteristics of multiple CIGS solar cells, with three different gallium content [Ga]/([Ga]+[In]) of 0.28, 0.64 and 0.81 varying between copper-poor and copper-rich compositions, 0.33<[Cu]/([Ga]+[In])<1. The cells were measured with a white LED (5000 K) from 45000 lx down to extremely low illumination (~50 lx). We then fit the experimental data, using a single set of parameters (R_p, R_s, n, I_0), with the classical one diode-model combined with an experimental collection term [Sun2016], and were able to correctly reproduce the illuminance dependence of the I-V electrical characteristics of the cell over three orders of magnitude.

Notably, the highest shunt resistance is achieved with a low copper composition, between 0.45 and 0.5, regardless of the gallium content. These cells demonstrated a remarkable increase of the maximum power by a factor of one thousand compared to copper rich CIGS solar cells, under low light conditions (50 lx).

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