Evaluation of Integrated and Local Electrical Parameters of a Silicon Solar Cell from Camera Lock-In Carrierography (LIC) and Lock-In Thermography (LIT)

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A theoretical analysis of NIR photon flux through radiative recombination and thermal emission through nonradiatively recombining excess minority carriers under modulated super-bandgap laser excitation in solar cell will be presented. The developed optoelectronic and thermoelectronic expressions allow the noncontact determination of solar-cell electrical parameters such as dark saturation current, ideality factor, solar conversation efficiency, fill factor, photogeneration current density and maximum power photovoltage based on statistical camera pixel distributions of carrierographic or thermographic images obtained over the entire solar cell surface area. The reliability of the LIC and LIT evaluated parameters was confirmed by means of traditional electrical measurements. It is shown that carrierographic images have higher spatial resolution and sensitivity to local distribution of parameters than the respective thermographic images. All-optical non-contact-generated current-voltage (I-V)-equivalent characteristics of multicrystalline solar cells will be presented using laser intensity scans in lieu of photovoltage variation changes through external load resistance changes, and the associated collected radiative recombination flux in lieu of electrical current.