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Cross-sectional characterization of the mobility of photovoltaic semiconducting devices via photocarrier extraction by linearly increasing voltage

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Appropriate characterization is vital for improvement of the electronic properties of semiconductors in photovoltaic devices, which will enable solar energy to compete with non-renewable energy sources. A critical electro-optical characterization tool for determining the carrier mobility in thin-film solar cells is offered by photo-carrier extraction by linearly increasing voltage (photo-CELIV) [1], in which a nano-second laser pulse is applied to a device followed by a linear extraction voltage ramp. The maximum intensity and extraction time of the transient offer information on the photocarrier mobility. In this presentation, we describe how a photo-CELIV apparatus has been integrated with a confocal optical microscope to extend the ability of photo-CELIV to obtain cross-sectional mobility profiles along the z-axis of a solar cell. High laser power density at the microscope's focal plane leads to a drastic increase in non-geminate recombination, such that the concentration of charge carriers extracted from the microscope focal plane saturates. A model has been developed to analyze the photo-CELIV transients at each confocal plane and calculate the cross-sectional mobility profile based on discretization of the active layer into N slices of unknown mobility. To test this method, we apply it to a hydrogenated amorphous silicon (a-Si:H) solar cell, which is a well understood material, and thus well suited for testing this novel characterization technique. Comparison of our results with measurements of the hydrogen content profile shows very good correlation, allowing for direct confirmation of our obtained mobility profile.

[1] Juška et al, Phys. Rev. Lett., 2000, 84, 4946

Keyword-1

Charge carrier mobility

Keyword-2

Current transient techniques

Keyword-3

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