SUB-SURFACE LUMINESCENCE LIFETIME IMAGING OF PHOTOVOLTAIC MATERIALS WITH MULTIPHOTON TOMOGRAPHY

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The recombination time of optically excited carriers is a critical parameter to assess (new) photovoltaic materials. With industrywide used one-photon-excitation-characterization methods, it is dominated by surface effects whereas bulk properties cannot be separately measured. In contrast, with two-photon excitation, the inside of the photovoltaic material becomes “optically accessible” [1]. This is achieved by focusing fs pulses with below-the-bandgap-photon energies which then excite two-photon interband transitions only inside the focal volume. In this way, the luminescence lifetimes of surface and bulk carrier-recombination effects are separated. The 3D-luminescence lifetime imaging provides information on local defects and crystalline grain boundaries. Furthermore, since the luminescence lifetime reflects the carrier lifetime and, by that, the solar-cell efficiency, direct 3D imaging of solar-cell properties become possible by spatially resolved luminescence-lifetime measurements. We present results on 3D photoluminescence lifetime and SHG imaging and in forward and backward directions of CdTe-solar films and discuss possibilities of a novel compact two-photon-tomography platform for solar-cell characterization.

[1] E. S. Barnard et al. Probing carrier lifetimes in photovoltaic materials using subsurface two-photon microscopy. Scientific Reports 3(2013)2098.

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