3D FLIM microscopy for photovoltaics: revealing defects in solar cells with multi-photon lifetime microscopy

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FLIM microscopy has the capability to probe optical-excitation phenomena in many optoelectronic materials systems, including LEDs, solar-cells and photo-detectors. The efficiency of a solar cell is correlated to the optically-excited lifetime of the semiconductor film used. Defects and crystalline boundaries diminish the performance of the cell. Our multi-photon FLIM 3D tomography system allows mapping of carrier lifetime in multi-crystalline photovoltaic film where we observe lifetime changes at crystalline grain boundaries and at local defects throughout the film. This allows to assess the quality of multi-crystalline materials for photovoltaic applications at an early stage of the development process and measure subsurface carrier dynamics that are inaccessible with traditional optical techniques. For example, our work using 3D FLIM on CdTe solar cells reveal how processing with a $CdCl_2$ treatment heals defects located at crystalline grain-boundaries and at the crystal buried p-n junction, ultimately leading to significantly higher performance of the cells.