Investigation of defects in CdTe thin films with high-resolution and time-resolved cathodoluminescence mapping

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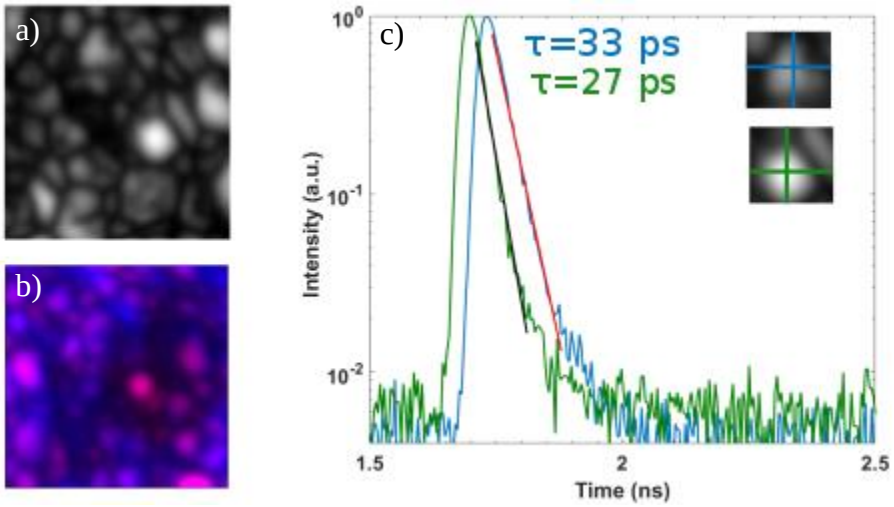
CdTe thin-film solar cells have reached efficiencies up to 22.1% with low-cost fabrication processes. They are made of polycrystalline layers with grains at the micrometer scale. For further improvements, the dopant incorporation, material quality, homogeneity and grain boundary passivation should be better controlled. In particular, defects can occur either in the grains or at the grain boundaries, and have a tremendous effect on the performance of thin-film solar cells. They can be partially suppressed or passivated by post-deposition treatments. Their density and their impact on the optoelectronic properties and the recombination dynamics need to be probed at the sub-micrometer scale, which cannot be performed by conventional photoluminescence techniques.

In this work, we use high-resolution cathodoluminescence (CL) mapping at both low and room temperature. Defects are identified spectrally and spatially, diffusion lengths in the vicinity of grain boundaries are assessed, and the impact of the injection regime is investigated. A pulsed electron beam is also used for time-resolved CL measurements in single grains, providing a novel way to reveal the intrinsic lifetime of carriers as a function of the grain size and defect density. This work is carried out on several samples, and the effect of various post-deposition treatments is discussed.



Figures : a) panchromatic CL image of CdTe thin film b) in red the average intensity between [775nm;787nm] corresponding to excitonic luminescence and in blue the average intensity between [810nm;890nm] corresponding for defects luminescence c) Decays for two grains measured with a STREAK camera