On the local optical density of states in planar and structured perovskite films

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Following Fermi's Golden Rule, the transition rate for radiative optical transitions is proportional to the local optical density of states (LDOS). This was first demonstrated experimentally for dye-doped organic thin films.(1) Experiments on rare-earth doped dielectrics showed how control and modulation of the LDOS can serve to derive the quantum efficiency of optical transitions.(2)

Here, we analyze the effect of LDOS variations in halide perovskite thin films in planar and multi-junction solar cell geometries. We show how the LDOS varies strongly with depth due to strong refraction and reflection at the dielectric boundaries. As a result, the quantum efficiency for radiative band-to-band transitions in perovskite films shows strong a variation with depth. We show how the corrugated surface topography of polycrystalline perovskite films also creates a laterally varying LDOS distribution. As a consequence, the emission quantum efficiency in perovskite films shows lateral variations across the film as well.(3)

We will discuss how and to what extent the effects of varying LDOS affect typical photovoltaic energy conversion processes such as optical reabsorption and photon recycling, the angular distribution of light emission and associated entropy losses, and spontaneous emission and reabsorption in multi-junction solar cells.

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