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Ultrafast Hole-Transfer Dynamics in Plastic Solar Cells

Abstract: Plastic photovoltaic (PV) solar cells are becoming increasingly efficient, and the technology is rapidly on its way toward mass scale applications. The power producing layer of a plastic PV cell is made of a mixture of two types of molecules, called donors and acceptors. Because the standard types of donor materials in these solar cells are colored semiconducting polymers, this PV technology is often called "plastic". While many different donor polymers have being developed to make better solar cells, the acceptor molecules are almost invariably made of soluble forms fullerenes. The current paradigm is that upon absorption of light, the polymer molecules transfer electrons to the fullerene molecules, as the first step in the overall electrical power production process.

We have recently demonstrated that next to the well-studied charge generation through photoabsorption by the polymer, the fullerene derivative also contributes substantially to the charge generation through the so-called hole-transfer process. The hole transfer occurs within 30 fs, which is – curiously enough - as fast as the electron transfer. Combining these findings with atomic-force microscopy data, we observed that the layer morphology strongly influences the hole transfer process.