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Highly efficient organic evices using doped transport layers

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Abstract – In the past few years, we have developed techniques for stable and efficient molecular doping of organic semiconductors. Using such layers, highly efficient devices such as organic light emitting diodes (OLED) and solar cells can be realized.

Organic semiconductors are currently investigated intensively, both because the basic physics are little understood and because of attractive application possibilities, such as flat-panel displays based on organic light emitting diodes (OLED). Despite the fact that organic semiconductors have, in particular as thin films, rather low mobilities, they perform surprisingly well in optoelectronic devices. OLED have reached outstandingly high efficiency, in some cases higher than their inorganic counterparts, and also very encouraging stability parameters.

In the past few years, we have investigated the controlled electrical doping of organic semiconductors using molecular dopants in detail /1/. Using such layers, we have realized some archetype semiconductor devices such as the pn-homojunction /2/. The doped layers also significantly improve the efficiency of devices and allow to realize new concepts such as tandem devices in a very simple manner.

First, I will discuss some key steps towards highly efficient OLED devices. The concept of molecular doping allows realizing monochrome /3/ and white OLED devices with very low voltages. Furthermore, the design of the emitter layer system is crucial for achieving high efficiency and long lifetime. I will discuss recent results for white OLED surpassing fluorescence tube efficiencies /4/. These devices also show very little roll-off even at high brightness due to control of exciton quenching.

Also, I will discuss organic solar cells. In particular, I will address novel absorber materials for small-molecule solar cells and the use of electrically doped transport layers. The latter approach is very helpful for an optimized optical design since it yields large freedom in the choice of window layer thickness and allow efficient trandem cells /5/.

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