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Highly Efficient Organic Devices

Organic semiconductors with conjugated electron system are currently intensively investigated for optoelectronic applications. This interest is spurred by novel devices such as organic light-emitting diodes (OLED), and organic solar cells. For both devices, high efficiency is a key parameter for many applications. In this talk, I will discuss some of the recent progress on highly efficient OLED and solar cells, in particular results using doped transport layers ^{/1/}: Surprisingly, doping (for raising the conductivity) has been largely ignored till now in organic devices, in contrast to classical silicon technology where controlled n- and p-type doping has always been a standard technique needed for virtually all devices.

The concept of molecular doping allowed to realize green OLED devices with the highest efficiencies reported so far ^{/2/}, well exceeding the efficiency of current inorganic GaN LED! The devices were pin-devices where the emitting layer is embedded between a p-doped hole transport layer and an n-doped electron transport layers. It has been shown that these pin-structures can also achieve extremely long lifetimes. White OLED have recently achieved very high efficiencies of 90lm/W ^{/3/}, significantly higher than fluorescent tubes, opening the path to a new form of high-efficiency area lighting devices.

The doping concepts can be applied in organic solar cells as well. Here, the use of electrically doped transport layers is helpful for an optimized optical design since it yields large freedom in the choice of window layer thickness, this making it easy to put the absorber layers in the electric field maximum in the cavity. Also, doped layers are a key point in efficient charge recombination junctions for tandem solar cells: It has been shown that a pn-junction is an excellent recombination contact causing very small voltage loss. Recently, we have achieved solar cells with certified efficiency exceeding 6% on larger area.

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