Hybrid Inorganic/Organic Systems for Opto-Electronics

Collaborative Research Centre 951

Special Colloquium Announcement

of the Collaborative Research Centre 951
"Hybrid Inorganic/Organic Systems for Opto-Electronics"

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The new generations of active-layer materials for organic electronics: Recent advances

Time: Monday, 05.06.2023, 15:15

Location: Erwin-Schrödinger-Zentrum,
Rudower Chaussee 25, 12489 Berlin
Room 0'119

Meeting-ID: 615 2251 9123
Password: 209487

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The new generations of active-layer materials for organic electronics: Recent advances

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We will first describe recent advances that have been made in two key areas of organic electronics: Organic light-emitting diodes (OLEDs) and organic photovoltaics (OPV). While OLEDs based on phosphorescent emitters (incorporating heavy-metal ions) have become nearly ubiquitous and represent a global market predicted to surpass to US$50B in 2023, the emergence of efficient non-fullerene acceptors some eight years ago has allowed the power conversion efficiency of OPV devices to increase remarkably, from some 11.5% to nearly 20%.

We will then discuss our recent theoretical work dealing with two strategies to design efficient, purely organic emitters and get rid of any heavy metals: The first was introduced in 2012 by Chihaya Adachi and co-workers at Kyushu University, who proposed to harvest the triplet excitons in purely organic molecular materials via thermally activated delayed fluorescence (TADF). These materials now represent the third generation of OLED emitters. Impressive photo-physical properties and device performances have been reported, with internal quantum efficiencies approaching 100%. The second and more recently applied strategy was proposed by Feng Li and co-workers at Jilin University in 2015 and is based on the exploitation of stable organic radicals. In these materials, when the lowest excited state and the ground state both belong to the doublet manifold, high efficiencies and photo-stability can also be obtained.

Finally, turning to OPV, we will highlight how the combination of our computational work together with experimental data coming in particular from temperature-dependent electroluminescence measurements: (i) allows a reliable description of the nature and energetic distribution of the charge-transfer electronic states that mediate exciton dissociation, charge separation, and charge recombination ; (ii) offers a unified view of the non-radiative voltage losses in both fullerene-based and nonfullerene-based devices; and (iii) provides guidance for the design of next-generation, high-efficiency OSC blends.