Abstract

Trap states can severely obstruct the charge transport in organic semiconductor materials. Therefore, a convenient toolset for in-situ monitoring of charge traps is important to understand their influences on the device performance. In this study, a combination of trap-sensitive magnetic field effects (MFEs) and impedance spectroscopy – a well-established technique for probing trap states – is used for efficient analysis of the evolution of the trap density.

In general, trap states occur intrinsically in amorphous organic layers due to their natural energetic disorder. However, photochromic compounds as the dithienyethene derivate **XDTE** can be used to generate an intentionally modifiable distribution of trap states. Therefore, this material provides an excellent system to, on the one hand, characterize the response of this toolset and, on the other hand, gain a deeper understanding of trap state's relevance for the switching process. Depending on the switching procedure, a significant impact of trapping effects on the switching process of the **XDTE** itself can be observed. Besides the impact of these trapping effects, the majority charge carrier type is changed by the switching process. This gives a further contribution to the MFEs and opens up the possibility to distinguish between the effect strength of the bipolaron mechanism and the *e*-*h*-pair mechanism to the total MFE amplitude. In combination with frequency-dependent capacity measurements, a complex interplay between these two MFE-mechanisms is revealed in the parameter space of switching state and probe voltage.

In addition, the impact of different spin-mixing channels on MFEs is examined. Therefore, MFEs in organic light-emitting diodes (OLEDs) with intra- as well as intermolecular emitter systems based on thermally activated delayed fluorescence (TADF) are analysed. Temperature-dependent measurements are well-suited to investigate the magnetic field influence on the transition rates between singlet and triplet states. Pronounced responses to the applied magnetic field are found in the intermolecular exciplex-based emitter. These can be traced back to additional contributions by the Δg-mechanism.

In summary, the relevance of trapping events for the switching process of the photochromic material **XDTE** is monitored by a novel toolset of MFEs and impedance spectroscopy. Moreover, a joint analysis of various trapping conditions and correlated MFEs is presented. Further in-depth investigations on MFEs in TADF-based OLEDs help to identify the relevant spin-mixing channels that are sensitive to external magnetic fields by analysing their temperature dependence.