Observation of Spin States involved in Organic Electroluminescence Based on Thermally Activated Delayed Fluorescence

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Organic light emitting diodes (OLEDs) based on thermally activated delayed fluorescence (TADF) have high potential for economical and sustainable lighting applications. The efficiency of the TADF pathway is only partially governed by the spin statistics of injected electrons and holes, in which the intermediate exciplex state at the interface of two molecules is formed in the emissive singlet spin configuration with a probability of only 25%, while 75% of excitations are in a non-radiative triplet state. The most commonly used approach to access the triplet states are phosphorescent materials containing a heavy metal atom like iridium or platinum. The strongly increased intersystem crossing (ISC) rate yields internal efficiencies of emission as high as 100%. In a recently introduced class of materials, the energetic separation between the singlet- and triplet exciplex spin configurations is in the range of thermal energy, enabling an efficient reverse intersystem crossing (RISC) from triplet- to singlet states without the use of heavy metals. In this study, we report the first application of electroluminescence detected magnetic resonance (ELDMR) techniques on TADF materials and indubitably proof the involvement of spins in the emergence of TADF electroluminescence. Temperature dependent studies of bilayer devices revealed that such spin-dependent processes of light emission are truly thermally activated.