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Spin-Orbital Coupling and Magnetoresistance Tuning in Organic Semiconductors

BIN HU, University of Tennessee

Magnetoresistance can be readily obtained from non magnetic organic semiconductors in light-emitting diodes. Tuning this novel magnetoresistance is an important issue in using an external magnetic field to control optoelectronic response in organic semiconductors. The experimental results indicate that weak-spin-orbital coupling materials exhibit much more significant magnetoresistance as compared to strong-spin-orbital coupling molecules. We find that uniformly mixing strong-spin-orbital-coupling fac-tris (2-phenylpyridinato) iridium [$Ir(ppy)_3$] molecules and weak-spin-orbital-coupling poly(N-vinyl carbazole) (PVK) leads to a concentration-dependent magnetoresistance. There are three possible processes, namely intermolecular spin-orbital interaction, energy transfer, and charge transport, that can contribute to the concentration-dependent magnetoresistance. The magnetic field-dependent electroluminescence shows that an intermolecular spin-orbital interaction is formed in the PVK+$Ir(ppy)_3$ mixture. This intermolecular spin-orbital interaction modifies the singlet/triplet exciton ratio, changing further charge injection when the space charge carriers from exciton dissociation are considered. Based on this intermolecular spin-orbital interaction effects, metal electrode-dependent spin-orbital coupling and magnetoresistance have been demonstrated. This presentation will discuss the effects of spin-orbital coupling on magnetoresistance tuning through exciton dissociation and exciton-charge reaction in organic light-emitting diodes through controlling energy transfer and bipolar injection.