Magnetic Field Effects in Organic Semiconductors

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A magnetic field can cause a substantial change in electroluminescence, photoluminescence, electrical current, and photocurrent, generating magnetic field effects in organic semiconductors. In particular, these magnetic field effects present a new direction to develop organic spintronics by using all non-magnetic material components. In general, the intrinsic magnetic field effects can be attributed to two facts that (i) a magnetic field can change the singlet and triplet ratios in excited states and (ii) the singlets and triplets can have different contributions to electroluminescence, photoluminescence, electrical current, and photocurrent[1]. As a result, changing singlet and triplet ratios is a key issue in the development of magnetic field effects in organic materials[2,3]. In principle, an external magnetic field can change the singlet and triplet ratios through two major pathways: spin-dependent electron-hole pairing and field-dependent intersystem crossing in excited states[4]. We recently studied the relative contributions from spin-dependent electron-hole pairing and field-dependent intersystem crossing to magnetic field effects by adjusting electron-hole capturing distance based on intra-molecular and inter-molecular excited states in organic semiconductors. We found that adjusting electron-hole capture distance can significantly change the interplay between spin-dependent electron-hole pairing and field-dependent intersystem crossing and consequently tune the magnetic field effects with positive and negative signs. This presentation will discuss (i) how spin-orbital coupling can change spin-dependent electron-hole pairing, (ii) how singlets and triplets are involved in magnetic field effects, and (iii) how spin-dependent and spin-random electron-hole pairing can be changed, in tuning magnetic field effects with positive and negative signs towards the development of magnetic field effects-based organic spintronics.

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1 Progress report: Magnetic Field Effects in Organic Semiconductors, Bin Hu*, Liang Yan, and Ming Shao, *Adv. Mater*. **21**, 1, 2009.

2 Photovoltaic Processes of Singlet and Triplet Excited States in Organic Solar Cells, Zhihua Xu and Bin Hu*, *Adv. Func. Mater*. **18**, 2611, 2008.

3 Tuning Magnetoresistance and Magnetic Field-Dependent Electroluminescence through Mixing Strong-Spin-Orbital-Coupling Molecule and Weak-Spin-Orbital-Coupling Polymer, Yue Wu, Zhihua Xu, and Bin Hu*, *Phys. Rev*. B**75**, 035214, 2007.

4 Tuning magnetoresistance between positive and negative values in organic semiconductors, Bin Hu* and Yue Wu, *Nature Materials*, **6**, 985, 2007.