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Magnetic Field Effect in Organic Devices: the Role of Hyperfine, Exchange and Spin Orbit Interactions
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Recently we have observed a novel phenomenon in both magneto-electroluminescence (MEL) and magneto-conductance (MC) in a variety of organic light emitting diodes that consists of a sign reversal at very small magnetic fields ($B \leq 1$ mT), dubbed hereafter ultra-small magnetic field effect (USMFE) [1]. Similar response has been obtained in $MC(B)$ of unipolar organic diodes [2]. As B is reduced below the zero crossing field, the magnitude of the obtained MEL and MC increases to a maximum value at $B = B_m$, before diminishing at $B=0$. We found that B_m is isotope dependent: it is lower when the protons in the organic material are replaced by deuterons having a smaller nuclear magnetic moment and reduced hyperfine interaction (HFI), and is higher when the ^{12}C atoms (nuclear spin $I=0$, no HFI) are replaced by ^{13}C atoms ($I=1/2$, with finite HFI). We also found that B_m scales with the half width at half maximum, ΔB , of the high field response. From the $MEL(B)$ and $MC(B)$ responses, the marked isotope effect, and voltage and temperature dependencies we explain the USMFE as well as the width ΔB , as due to loosely coupled pairs of polarons (either with same or opposite charges) of which spins are intermixed via the HFI [1,2]. The model captures the sign reversal and its dependence on the HFI strength. The role of the HFI anisotropy, exchange interaction between the polaron pair spins, and spin orbit interaction effect on the USMFE will be discussed. *Supported by the Israel Science Foundation grant 745/08, and NSF grant DMR 08-03325. **In collaboration with T. D. Nguyen, B. R. Gautam, and Z. V. Vardeny, University of Utah.

[1] T. D. Nguyen, G. Hukic-Markosian, F. Wang, L. Wojcik, X-G. Li, E. Ehrenfreund, Z. V. Vardeny, *Nature Materials* **9**, 345 (2010).

[2] T. D. Nguyen, B. R. Gautam, E. Ehrenfreund, Z. V. Vardeny, *Phys. Rev. Lett.* **105**, 166804 (2010).