Magnetoresistance of field effect transistors based on organic multilayer film

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Singlet fission (SF) which transforms an excited singlet state into two excited triplet states has concentrated much attention because of its potential to increase the efficiency of organic solar cells. It has been reported pentacene shows efficient singlet fission [1, 2].

In this work, we studied the magnetoresistance (MR) response of the multilayer pentacene (PEN)/ perfluoro-pentacene (PFP) based field effect transistors under light illumination (Fig 1). The MR was turned from positive to negative when the gate voltage (V_g) changed from positive to negative. We observed competing processes: (i) the detraping of triplet exciton at the PEN/PFP interface and (ii) singlet fission in PEN layer. At negative V_g, the magnetoresistance shows a "W" shape negative MR curve with two peaks around ±50 mT (Fig 2). Under low magnetic field, the light illumination increases the singlet excitons or singlet excited states, which contributes to generate photocurrent and to decrease the resistance of device (negative MR). Under high magnetic field, the singlet fission process increases the triplet excited state resulting in the decrease of negative MR. At positive V_g, the detraping of triplet exciton at PEN/PFP interface is the dominated process resulting in the positive MR curve (Fig 3).

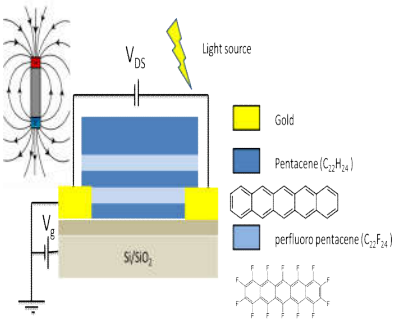

Figure 1: Device structure

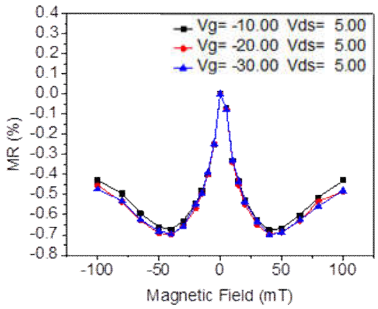

Figure 2: Magnetoresistance at V_g <0

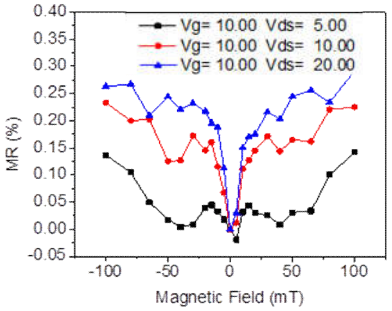

Figure 3: Magnetoresistance at V_g >0

References:

[1] Paul M. Zimmerman, Martin Head-Gordon, J. Am. Chem. Soc, 2011, 133 (49), pp 19944–19952.

[2] J. Lee, P. Jadhav, and M. A. Baldo, Appl. Phys. Lett. 95, 033301 (2009).