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Investigation of Magnetoresistance in Europium Based Organic Devices Using Magnetic Field Modulation Technique

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Abstract – The magnetoresistance effect (MR) at room temperature in thin layers of $Eu(btfa)_3bipy$: btfa=4,4,4-trifluoro-1-phenyl-2,4-butanedione, bipy=2,2'-bipyridine are presented and discussed. The measurements were performed in weak magnetic fields with encapsulated devices and the MR effect reached up to 3,5%. These preliminary results seem to confirm the presence of the MR also in devices based on rare-earth compounds with a strong spin-orbit effects.

Recently, a new interesting phenomenon was discovered for a number of small molecule and polymer organic semiconductors [1]. Giant magnetoresistance (MR) effects, up to 10-20%, were recorded at room temperature (RT) by using weak magnetic fields [2]. However, this phenomenon doesn't still have a comprehensive explanation and several models have been formulated in order to explain MR in organics as for example the electron-hole pair mechanism (EHP), the bipolaron mechanism and the triplet-exciton polaron quenching (TPQ). Normally, the MR effect in organic compounds is observed for weak spin-orbit coupling conditions.

In this work, by using the magnetic field modulation technique (MFMT) we was able to detect the magnetoresistance effect in a thin layer of a rare-earth based small molecule compound, $Eu(btfa)_3bipy$: btfa=4,4,4-trifluoro-1-phenyl-2,4-butanedione, bipy=2,2'-bipyridine. Measurements of MR in Tris(8-hydroxyquinoline)aluminum(III) (Alq_3) based devices were also performed in order to test the experimental setup and the sensitivity of the technique used. As result, MR values up to 5 % were obtained in agreement with literature [2, 3] (Fig.1).

All the devices were fabricated with heterojunction between a thermally deposited Eu^{3+} organic complex thin film (~ 80 nm) and a Poly(3,4-ethylenedioxythiophene) poly(styrenesulfonate) PEDOT:PSS layer. The PEDOT thickness and some parameters of the measurement system were also varied in order to find the best architecture to enhance the MR effect. Moreover, to avoid the moisture degradation all the devices were encapsulated using a special desiccant and geometry (*patent pending*). Differently from the majority of experiments in literature, the MR measurements were performed at RT and at ambient atmosphere by using an electromagnet from GMR Associates applying magnetic fields varying from zero until 500 mT. Values of MR up to 3,5% were obtained in $Eu(btfa)_3bipy$ based devices (Fig. 2). These preliminary results seem to confirm the presence of the MR also in devices based on rare-earth compounds with a strong spin-orbit effects.

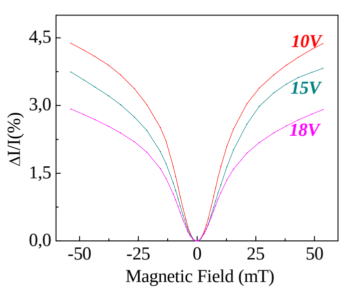

Figure 1: MR effect in Alq_3 devices as a function of bias voltage.

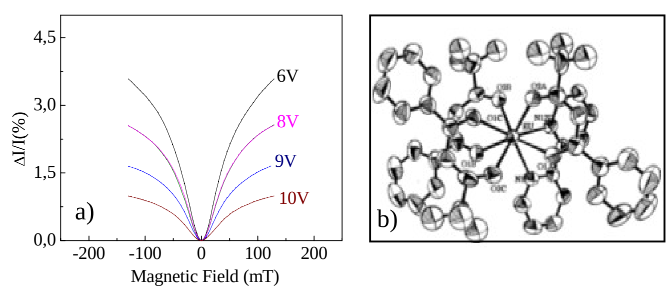

Figure 2: **a**) MR effect in $Eu(btfa)_3bipy$ devices as function of bias voltage. **b)** $Eu(btfa)_3bipy$ molecule.

References

[1] J. Kalinowski, M. Cocchi, D. Virgili, P. Di Marco, and V. Fattori, Chem. Phys. Lett. 380, 710, 2003.
[2] P. A. Bobbert, W. Wagemans, F.W. A. van Oost, B. Koopmans, and M. Wohlgenannt, Phys. Rev. Lett. 102, 156604, 2009.
[3] F. L. Bloom, W. Wagemans, and B. Koopmans J. App. Phys. 103, 07F320, 2008.