DS 1: Towards Molecular Spintronics

Time: Monday 9:30–11:30 Location: H 2013

Invited Talk DS 1.1 Mon 9:30 H 2013

Organic Spintronics five years later — •Carlo Taliani — Institure for Nanostructured Materials CNR, Bologna, Italy

The discovery of spin injection in organic semiconductors (OS) dates back to 2002 when we published the paper [1]. That defined the beginning of a new branch of science in which OS are active media for the most advanced frontier in electronics in which information rather than by charges are transported and manipulated by the polarization of spins. The application of OS, as weak spin scatterers, in spintronics started from the intuition that colossal magnetoresistance ceramic materials like LSMO and OS could form a suitable interface for spin injection but, for the development of the principle, it was essential to have, both the ability and the expertise to grow organic as well as inorganic thin films in the same scientific environment as we have at ISMN. We generated the first planar spin valve made by LSMO /sexythiophene/ LSMO and observed a large magnetoresistance (MR) at room temperature depending inversely with the channel length with a peak of 30% MR for 80 nm gap. Several groups have confirmed the discovery giving rise to a solid interdisciplinary community of chemists and physicists at the frontier between magnetism and semiconductivity. In this presentation I will give an overview of the advancement in this field with a special emphasis to the potentiality of novel hybrid organic/inorganic interfaces.

[1]Room temperature spin polarized injection in organic semiconductors by V. Dediu, M. Murgia, F.C, Matacotta, C.Taliani, and S. Barbanera, Solid State Commun. !22, (2002) 181.

Invited Talk DS 1.2 Mon 10:00 H 2013

Organic spintronics: can theory play a role? — •Stefano Sanvito — School of Physics and CRANN, Trinity College Dublin, IRELAND

The ability of manipulating electron spins in organic molecular materials offers a new and extremely tantalizing agenda for both spin- and molecular-electronics. This is mainly due to the unquestionable advantage of weak spin-orbit and hyperfine interactions in organic molecules, which leads to the possibility of preserving spin-coherence over long times and distances. Moreover novel experiments with magnetic molecules demonstrate the profound influence of the molecular magnetic degrees of freedom on the transport. Theory can play an important role in this field, since first principles methods allow us to make quantitative predictions without adjustable parameters. In this talk I will overview recent theoretical progress in the field, in particular in the area of spin-phenomena at the single-molecule level.

First I will discuss the feasibility of organic spin-valves. These can exhibit a large bias-dependent magnetoresistance, that can be engineered by an appropriate choice of molecules and anchoring groups. Then, I will turn my attention to magnetic molecules. I will show results for Mn12 sandwiched between magnetic and non-magnetic electrodes and demonstrate the influence of the magnetic spin-state on the transport properties of the device. This is a formidable theoretical challenges since the simulation cells contain more than 1,000 atoms.

Invited Talk DS 1.3 Mon 10:30 H 2013

Spintronic and electro-mechanical effects in single-molecule transistors — •Maarten R. Wegewijs — Institut für Festkörper-Forschung - Theorie 3, Forschungszentrum Jülich, 52425 Jülich, Germany — Institut für Theoretische Physik A, RWTH Aachen, 52056 Aachen, Germany

The ability to electrically control the current through a single molecule in a three-terminal device geometry has opened up exciting perspectives for single-molecule spintronics. For instance, we predicted transport effects related to the coherent magnetization tunneling in single-molecule magnets which exhibit substantial magnetic anisotropy. In particular, non-trivial Kondo effects allow for a complete determination of the magnetic properties of such a device by transport measurements [1].

Another key feature of single-molecule transistors is the coupling of the electric current to quantized vibrations. In this talk, we will show how internal vibrations of a molecular transistor may be correlated with the total spin. We show how the total spin length may be determined using Franck-Condon transport effects i.e. without using a magnetic field. Finally, we show how electric control of the molecular spin is made possible by current-driven vibrations of the molecule.

[1] M. R. Wegewijs, C. Romeike, H. Schoeller and W. Hofstetter, New J. Phys. 9 344, (2007).

DS 1.4 Mon 11:00 H 2013

Electrical detection of spin coherence in thin organic layers — •Sebastian Schäfer[1], Somaie Saremi[1], Wolfgang Harneit[1], Kati Hübener[1], and Konstantinos Fostiropoulos[2] — [1]Freie Universität Berlin, Institut für Experimentalphysik, Arnimallee 14, 14195 Berlin, Germany — [2]Hahn-Meitner-Institut Berlin, Abteilung Heterogene Materialsysteme, Glienicker Str. 100, 14109 Berlin, Germany

An experimental demonstration of electrical detection of coherent spin motion of weakly coupled, localized electron spins in thin Fullerene C_{60}-Films at room temperature is presented. Pulsed electrically detected magnetic resonance experiments on vertical photocurrents through Al/C_{60}/ZnO samples showed that an electron spin Rabi oscillation of $\approx 10^4$ spins is detected by transient current changes. The nature of possible microscopic mechanisms responsible for this spin to charge conversion as well as its implications for the readout of endohedral Fullerene (N@C_{60}) spin qubits are discussed. Furthermore, current experiments on thin layers relavant for organic photovoltaic devices are presented.

DS 1.5 Mon 11:15 H 2013

Spin-polarised charge carrier transportin Ni/Alq_3/Co structures — Martin Roggenbuck, •Andreas Opitz, and Wolfgang Brütting — Institute of Physics, University of Augsburg, Germany

The spin state of electrons can be utilised to extend the probabilities of electronic circuits. Organic semiconductors are materiales with high spin diffusion lengths and long spin relaxation times and therefore interesting candidates for spintronics. Recently, spin polarised transport has been reported for diode structures comprising Alq_3 as organic semiconductor sandwiched between two ferromagnetic electrodes [1].

In this work cobalt and nickel are used as electrode materials, which have a high work function and should be hole injecting. At low temperatures a negative magneto-resistance effect of $\Delta R/R \approx 4\%$ is observed. However, the measured I-V curves show a higher current in comparison to standard light-emitting devices, like ITO/PEDOT:PSS/Alq_3/LiF/Al. An analysis by secondary ion mass spectrometry confirms that cobalt diffuses into the Alq_3 layer up to a thickness of 70 nm. Furthermore small clusters appear on the Alq_3 film after cobalt deposition, as proven by scanning force and scanning electron microscopy. Nevertheless, the current of the device is still much higher than expected with regard to the reduced film thickness and the lower hole mobility than the electron mobility in Alq_3 [2]. This is an indication for a different origin of the magneto-resistance effect other than transport through the organic semiconductor.

[1] Z. H. Xiong, et al., *Nature* **427** (2004) 821.
[2] W. Brütting, et al., *Org. Electron.* **2** (2001) 1.