MA 30: Electronic structure of Surfaces: Magnetism and Spin Phenomena

Time: Tuesday 18:30–20:30 Location: P1A

MA 30.1 Tue 18:30 P1A

A silicon-based room temperature spin source without magnetic layers — •Debkumar Bhowmick, Matthias Kettner, Manfred Bartsch, and Helmut Zacharias — Physikalisches Institut, WWU Münster, Wilhelm-Klemm-Str. 10, 48149 Münster

Controlling the electron spin orientation and spin injection into functional electronic devices is of central importance in the field of spin transport electronics or spintronics. So far ferromagnetic metal/semiconductor junctions have been used to develop for spintronics which works only under low-temperature. Self-assemble chiral molecular monolayer (like dsDNA, Lysine) on gold shows promising in the direction of development of room temperature spintronic devices. In this present study, electron spin filtering by DNA on silicon, covalently bound by a 3-isothiocyanatopropyl triethoxy silane linker have been shown. This provides a means for developing room temperature spintronics. Electrons from silicon passing through double-stranded DNA acquire a longitudinal spin polarization. This enables the integration of helical molecules as spin filters in modern electronics for spin control, injection, and detection.

MA 30.2 Tue 18:30 P1A

A Riccati equation based model for chiral spin filters — •Daniel Nürenberg, Matthias Kettner, and Helmut Zacharias — Physikalisches Institut, Uni Münster, Germany

The spin selective transport of electrons in chiral molecules is currently under intense research in theory and experiment. These experiments include studies of the dependence of the spin polarization on the length of the molecules and on the starting spin polarization from the substrate. We show that the evolution of the spin polarization of an ensemble of electrons during propagation can be described by a Riccati equation, which can be fitted to experimental data. We propose that the coefficients in this model are suitable to characterize the efficiency of spin filters and help to distinguish spin-flip and perturbation from spin-dependent extinction effects. These perturbations also limit the spin polarization for long molecules. We apply our model to fit previous experimental data from DNA, oligopeptides and [7]-helicene.

MA 30.3 Tue 18:30 P1A

Enantiomer-dependency of spin orientation in photoelectron transmission through heptahelicene — •Matthias Kettner[1], Daniel Nürenberg[1], Johannes Seibel[2], Karl-Heinz Ernst[2], and Helmut Zacharias[1] — [1]Physics Institute und Center for Soft Nanoscience, University of Münster, Germany — [2]Nanoscale Materials Science, EMPA, Switzerland

Spin transport electronics (spintronics) enables a new generation of efficient electronic and non-volatile memory devices. Though the concept of spintronics is well known, the field still lacks devices that work under ambient conditions. Experiments on self-assembled monolayers of double stranded DNA [1,2] and oligopeptides [3] indicated a very efficient spin filtering behavior of the molecules at room temperature. In present experiments enantiopure M- and P-heptahelicene molecules are evaporated onto noble metal single crystal surfaces. The molecules arrange themselves to a highly ordered monolayer [4]. Samples are then irradiated with $\lambda = 213\,\mathrm{nm}$ laser radiation to generate photoelectrons from the substrate. These electrons are transmitted through the heptahelicene layer and analyzed with regard to their average longitudinal spin orientation by a Mott polarimeter. The sign of the spin polarization is related to the helicity of the enantiomer whereas an influence of substrate on the spin-filter effect has not been observed.
[1] Göhler, B. et al., Science 2011, 331, 894. [2] Kettner, M. et al., Adv. Mater. Interfaces, 2016, 3, 1600595. [3] Kettner, M. et al., J. Phys. Chem. C 2014, 119, 26. [4] Ernst, K.-H., Acc. Chem. Res. 2016, 49, 1182.

MA 30.4 Tue 18:30 P1A

Laser induced photocurrents in a Topological Insulator thin film analyzed by 2D maps for VIS and NIR — •Thomas Schumann[1], Helena Reichlová[3], Gregor Mussler[4], Eva Schmoranzerová[2], Petr Němec[2], Tobias Kampfrath[5], Christian Heiliger[6], and Markus Münzenberg[1] — [1]IfP, University of Greifswald, Germany — [2]MFF, Charles University, Prague, Czech Republic — [3]FZU, Prague, Czech Republic — [4]PGI-9, Jülich, Germany — [5]FHI Berlin, Germany — [6]University of Gießen, Germany

Topological Insulators (TI) open up a new route to influence the transport of charge and spin in a surface film via spin-momentum locking [1,2]. It has been demonstrated experimentally [2] that illumination by circularly polarized light can result in excitation of a helicity-dependent photocurrent. We report our recent results on laser induced photocurrents in a terniary 3D TI thin film. The resulting photocurrents have been studied by 2D photocurrent maps for different dopings and for VIS to NIR laser excitation. We although discuss the effects of contacts and edges if they are illuminated by the laser.
[1]S.D.Ganichev,W.Prettl,J.Phys.: Condens. Matter 15 (2003) R935-R983

[2]J.W.McIver,D.Hsieh,H.Steinberg,P.Jarillo-Herrero and N.Gedik, Nature Nanotechnology 7, 96-100 (2012)

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MA 30.5 Tue 18:30 P1A

Inelastic Excitations on Fe-TPyP on Au(111) — •Daniela Rolf, Christian Lotze, Benjamin W. Heinrich, and Katharina J. Franke — Freie Universität Berlin

Prophyrin molecules constitute a class of well-investigated molecules, due to their versatility in terms of self-assembly and electronic and magnetic properties. Numerous studies have been performed with different central metal atoms on different metal surfaces, showing that by a suitable choice of metal center and surface, the molecular properties can be tailored. Interesting phenomena were observed, including the Kondo effect, vibronic coupling and negative-differential resistance.

Here, Fe-tetra-pyridil-porphyrin (Fe-TPyP) molecules were investigated on a Au(111) substrate. Employing a low-temperature STM, we show that a multitude of steps in the dI/dV-signal up to 135meV can be observed symmetrically around the Fermi level. These inelastic excitations were observed both on the Fe-center of the molecule as well as on the organic TPyP ligand, with some of the steps on the ligand being visible only at positive bias polarity. As none of the inelastic excitations could be observed on chlorine-coordinated Fe-TPyP-Cl molecules, molecular vibrations were excluded as the origin of the inelastic excitations. Instead, a contribution of magnetic origin is assumed.

MA 30.6 Tue 18:30 P1A

Yu-Shiba-Rusinov states and inelastic excitations in Iron Porphine molecules on Pb(111) — •Laëtitia Farinacci, Gaël Reecht, Benjamin W. Heinrich, and Katharina J. Franke — Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany

When adsorbed on a superconductor, magnetic impurities couple to the quasi-particles of the substrate. This interaction induces Yu-Shiba-Rusinov (YSR) states within the BCS gap of the superconductor whose energy depends on the coupling strength. In case of a vanishing coupling, they merge with the gap edge and it may be possible to observe inelastic excitations outside of the BCS gap.

Using STM we investigate the properties of Iron Porphine molecules on a Pb(111) surface. After deposition, the molecules form islands with a hexagonal pattern. Within these islands, two different types of molecules can be identified. Type I molecules show a clover shape with a central protrusion while type II molecules have a square-like appearance. YSR states are observed above type I molecules. Depending on their surroundings type II molecules can display inelastic excitations outside the BCS gap of Pb(111).

By approaching the tip closer to the molecules we are able to tune the energies of these YSR states and inelastic excitations. In particular, the YSR states can be suppressed.

MA 30.7 Tue 18:30 P1A

Investigation of Ferromagnetism on Graphite due to Swift Heavy Ion Irradiation — •Eren Güvenilir[1], Cem Kincal[1], Umut Kamber[1], Dilek Yildiz[1,2], Clara Grygiel[3], Cornelis J. Van Der Beek[4], and Oğuzhan Gürlü[1] — [1]Istanbul Technical University, Istanbul, Turkey — [2]University of Basel, Basel, Switzerland — [3]Universite de Caen, Caen, France — [4]Ecole Polytechnique, Palaiseau

Defect induced ferromagnetism have been reported on carbon based

materials. In this work we investigated the magnetic properties of highly ordered pyrolytic graphite (HOPG) samples after irradiation with swift heavy ions (SHI). Samples were irradiated under 80° and 87.5° angle of incidence using highly charged and highly energetic Pb and U ions. Such SHI irradiation generates comet-like defects on the sample surfaces. We performed magnetic force microscopy under atmospheric ambient conditions. Our measurements revealed that comet-like defects caused by SHI irradiation have significantly higher magnetic signal compared to native defects on HOPG surfaces.

MA 30.8 Tue 18:30 P1A

Spin-resolved electron transmission through self-assembled layers of PNA — •Paul Möllers[1], Matthias Kettner[1], Daniel Nürenberg[1], Francesco Tassinari[2], Tal Z. Markus[2], Catalina Achim[3], Ron Naaman[2], and Helmut Zacharias[1] — [1]Physikalisches Institut, Universität Münster, Germany — [2]Department of Chemical Physics, Weizmann Institute, Rehovot, Israel — [3]Department of Chemistry, Carnegie Mellon University, Pittsburgh, Pennsylvania, United States

The yield of electrons transmitted through chiral molecules can depend on the electron's spin; chiral molecules can therefore act a spin filters. This effect is referred to as the chirality-induced spin selectivity (CISS). Previous experiments have e.g. been performed with monolayers of double-stranded DNA [1]. In this contribution, we present results of our spin-resolved photoemission experiments performed at room temperature. The samples consist of self-assembled monolayers of helical molecules – various types of double-stranded peptide nucleic acid (PNA) – on polycrystalline gold surfaces. The samples are irradiated by a laser at $\lambda = 213\,\mathrm{nm}$ to generate photoelectrons from the gold substrate which are then transmitted through the adsorbed monolayer. Subsequently, the electrons are analyzed by a Mott polarimeter. We found longitudinal spin polarizations of $-5\,\%$ for PNA and $+4\,\%$ for γ-PNA. The results indicate that the adsorbed molecules act as a spin filter.

[1] B. Göhler et al., Science 331, 894 (2011)