Defect induced magnetism in ZnO: A first spintronic device application

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The appearance of a magnetically ordered state in a nominally non-magnetic material through atomic lattice defects with a concentration of roughly five at. Percentage depends on the details of the lattice structure and the elements involved. The phenomenon Defect-Induced Magnetism (DIM) has been found in a broad spectrum of materials, like graphite, SiC and several oxides. The evidence for magnetic order obtained by different experimental methods like, e.g., Magnetization, XMCD, Electrical transport, EPR and NMR, leaves no doubt about its existence in solids. An interesting example of DIM in oxides is found in ZnO, a large gap semiconductor that has been thoroughly studied in the last ten years. DIM in pure ZnO can be induced by increasing the concentration of Zn vacancies through, e.g., proton irradiation. These defects can be stabilized in the ZnO lattice and remain above room temperature through previous doping with Li or Na, for example. The Curie temperature reached in this case remains always above 300K. In spite of a large amount of work, a possible application of DIM has not yet been realized. In this work, we present an electron-spin filter and a magnetoresistance sensor based on ZnO nanostructures, in which magnetic order was reached by introducing atomic lattice defects following the simple procedure to produce vacancies in ZnO through low-energy plasma treatment. The measured signals and the scalability of the phenomenon indicate a good potential of the observed phenomenon for applications in micro- and nanospintronics.

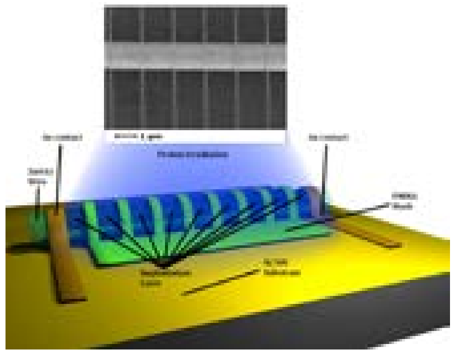

Figure 1: Schematic of the magnetoresistance sensor device based on a spin filter effect at the interface between defect-induced magnetic and non-magnetic regions at the surface of a ZnO:Li wire. (top) SEM picture of a ZnO:Li wire as prepared for proton implantation.

Biography

Lukas Botsch has his interests in the field of magnetic materials and spintronic applications. During his Master in Physics, he studied Magnetic Semiconducting Oxides and their application in Optics and Spin Electronics. Working on his PhD, he is now studying defect-induced magnetism as a framework for semiconductor based spintronics.

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