# MA 32: Magnetic recording, sensors and other devices

Time: Wednesday 12:00–13:00 Location: H53

MA 32.1 Wed 12:00 H53

**Properties of Magnetoresistive Sensors in Vortex-Configuration** — •Christoph Durner[1,2], Wolfgang Raberg[1], Klemens Pruegl[1], and Jonathan Finley[2] — [1]Infineon Technologies AG, 85579 Neubiberg, Germany — [2]Walter Schottky Institute, E24, Technical University of Munich, 85748 Garching, Germany

Many automotive applications, such as wheel speed, require magnetic sensors with negligible small hysteresis and a wide linear operating range. All these requirements can be met using a Tunneling Magnetoresistance (TMR) spin-valve sensor with the free layer (FL) in the vortex (V) state. The V state is characterized by a closed rotationally symmetric magnetization with a centered z-component, the V core. Usually, the FL exhibits a disk-like shape to enable a V-like magnetization. In reality the FL cannot be processed perfectly cylindrical. The shape alteration leads to a variation of the V behavior upon external magnetic fields and therefore, in a modified electrical signal. Micromagnetic simulation were used to successfully match the magnetization of the FL to the observed electric behavior under the influence of an external magnetic field in dependence of differences in FL structuring. Another focus of the investigations was the improvement of the TMR stack, in particular the layers responsible for the tunneling process, namely free layer, tunnel barrier, and reference layer (RL) system. By optimizing the ferromagnetic material composition and thicknesses of the FL and RL significant improvement of the TMR ratio by a factor of two as well as an improved stability of the entire system with respect to high temperature annealing was achieved.

MA 32.2 Wed 12:15 H53

**Mechanically controlled magnetization reversal in single-domain particles** — •Thomas Mühl, Stefan Philippi, Heike Schlörb, Dipankar Mukherjee, and Bernd Büchner — IFW Dresden, Dresden, Germany

Magnetization reversal of small ferromagnetic particles requires to overcome an energy barrier which is mainly defined by the magnetic anisotropy. Usual reversal stimuli include the application of static or time-dependent external magnetic fields, thermal activation, spin transfer torque, or combinations thereof. Here, we report on quasi-periodic magnetization reversal in single-domain particles that are exposed to a constant magnetic field perpendicular to the magnet's easy axis. The continuous sequence of reversals is induced by torsional oscillations of the magnet's anisotropy landscape, which are caused by angular oscillations of the magnet's body. In our experiments, a nickel nanowire constitutes both a mechanical resonator and a nanomagnetic sample with uniaxial anisotropy. We measure the transient flexural vibration behavior by electron beam based methods and find strong signatures of periodic magnetization switching between two magnetic states of the nanowire. Furthermore, we extend our approach towards mechanically-controlled single reversals of magnetization that are induced by pulsed mechanical excitation. The latter might be the foundation for a novel ansatz for energy-efficient magnetic data storage.

Ref.: S. Philippi, H. Schlörb, D. Mukherjee, B. Büchner, T. Mühl, Nanotechnology 29, 405503 (2018).

MA 32.3 Wed 12:30 H53

**Nano Hall Sensors for Scanning Magnetic Field Microscopy** — •Manuela Gerken[1], Davood Momeni Pakdehi[1], Thomas Weimann[1], André Müller[1], Aurélie Solignac[2], Andrin Doll[2], Klaus Pierz[1], Frank Hohls[1], Sibylle Sievers[1], and Hans Werner Schumacher[1] — [1]Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany — [2]SPEC, CEA, CNRS, Université Paris-Saclay, CEA Saclay, Gif sur Yvette Cedex, France

Within the overall miniaturization, also magnetic devices are being scaled down into the micro- and nanometer range. This leads to an increasing demand for high-resolution quantitative metrology to measure the resulting inhomogeneous device stray fields. One promising approach is scanning magnetic field microscopy using nanoscale Hall sensors. Here, we will present our results on the development of gold and graphene Hall sensors with active areas down to 50 nm x 50 nm.

The sensors were fabricated using combinations of electron beam lithography, lift-off process and etching of epitaxially grown graphene. To investigate sensor sensitivity as well as stability they were characterized in homogeneous magnetic fields up to 250 mT. For the sensor calibration we will give an estimation of the uncertainty budget. Finally, we will present a concept how to fabricate gold Hall sensors on cantilevers to integrate them into a metrological AFM for quantitative and high precision scanning Hall magnetometry.

MA 32.4 Wed 12:45 H53

**Improvement of band matching by monolayer Ni insertion at the $Co_2FeGa_{0.5}Ge_{0.5}$/Ag interfaces in current-perpendicular-to-plane pseudo spin valves** — •Björn Büker[1,2], Jin Won Jung[2], Yuya Sakuraba[2], Yoshio Miura[2], Taisuke Sasaki[2], Andreas Hütten[1], and Kazuhiro Hono[2] — [1]Bielefeld University, Bielefeld, Germany — [2]NIMS, Tsukuba, Japan

All-metallic current-perpendicular-to-plane giant magnetoresistive devices (CPP-GMR) using half-metallic Heusler alloys have gathered a lot of interest lately, e.g. as next generation read heads for high density hard drives. For further enhancement of the MR ratio, interfacial spin-dependent scattering, which is directly related to the electronic band matching of the Heusler and the non-magnetic spacer, is an important factor for optimization. Recently Jung et al. have demonstrated a large enhancement of the MR ratio to more than 80% in $Co_2FeGa_{0.5}Ge_{0.5}$ /Ag/ $Co_2FeGa_{0.5}Ge_{0.5}$ (CFGG) structures by inserting thin layers of NiAl at the CFGG/Ag interface, even though Al showed undesired interdiffusion. Therefore, we have performed a systematic study on thin layers of pure Ni at the CFGG/Ag interface, in order to investigate the mechanism of the enhanced magnetoresistance caused by the inserted layer.

The pseudo spin valve (PSV) films were prepared on a MgO(001) substrate. The MR ratio increased significantly from 27% for $t_{Ni}$=0 nm to 44% for $t_{Ni}$=0.21 nm. HRTEM images of the interface along with atomic resolution EDS elemental mappings confirm a Ni monolayer at the interface.