Walther-Meißner-Institut

Bayerische Akademie der Wissenschaften

Walther-Meißner-Seminar

Walther-Meißner-Institut, Seminar Room 143

Date: **Friday, 11 November 2016, 13:30 h**

Speaker: **Dr. Andy Thomas**

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Title: **Atomic layer deposition for spinelectronic devices**

Abstract:

Magnetic tunnel junctions (MTJs) consist of two ferromagnetic electrodes separated by a thin insulating tunnel barrier. In these devices, the tunnel magnetoresistance effect can be observed, i.e. different electrical resistance values of the tunnelling current for the parallel and antiparallel alignment of the magnetizations of the two electrodes [1]. Ever since this effect was observed at room temperature in 1995, it was used in many spintronic devices such as read heads in hard disk drives. In most cases, the required layer stacks are prepared by sputter deposition and subsequent optical/electron-beam lithography to define the tunnel junctions. However, a combination of atomic layer deposition (ALD) and sputtering would lead to new options for the preparation of MTJs and other spinelectronic devices. In particular, with respect to thin film quality, 3d conformity and large-scale production, which is required for industrial applications. Here, we combined sputter deposition of the ferromagnetic Co-Fe-B electrodes and ALD preparation of the HfO_2 tunnel barrier [2]. The barrier was prepared using tetrakis (dimethylamido) hafnium and water as precursors. Prior to and after the deposition, the sample was stored for 6 h under a constant argon-hydrogen flow (200°C) to allow the removal of any oxidized surface layer at the CoFeB/HfO_2 interface that may have formed. We investigated the TMR ratio, the temperature- and bias voltage dependence and compared the junction properties with sputtered magnesia and alumina based MTJs. Figure 1 depicts the room temperature TMR ratio of a HfO_2 based tunnel junction. In addition, we studied the structural properties via high-resolution transmission electron images and observed a polycrystalline/amorphous electrode barrier system. Finally, the barrier parameters are discussed within the framework a trapezoidal tunnel barrier and the temperature and bias voltage dependence in the context of magnon and phonon excitations [3].

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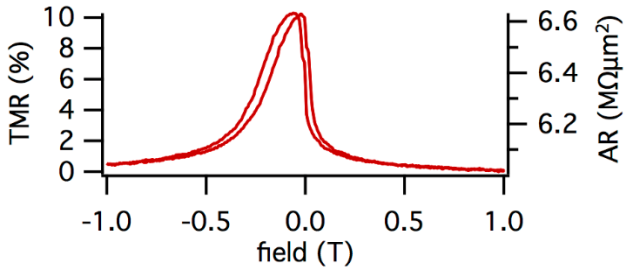

Figure 1: Tunnel magneto-resistance ratio of a HfO_2-based magnetic tunnel junction at 300K and an applied bias voltage of 10mV.

[1] J. Moodera et al., Phys. Rev. Lett. **74** (1995) 3273; [2] S. Fabretti et al., Appl. Phys. Lett. **105** (2014) 132405; [3] W. Brinkman et al., J. Appl. Phys. 41 (1970) 1915.