

Physikalisches Kolloquium

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»Magnetoresistance and spin-transfer torque in magnetic tunnel junctions«

Einführung: W. Wulfhekel

A magnetic tunnel junction (MTJ) consisting of a thin insulating layer (a tunnel barrier) sandwiched between two ferromagnetic electrodes exhibits the tunnel magnetoresistance (TMR) effect due to spin-dependent electron tunneling. Since the discovery of room-temperature TMR in the mid-1990s, MTJs with an amorphous aluminum oxide (Al–O) tunnel barrier have been studied extensively.

Such MTJs exhibit a magnetoresistance (MR) ratio of several tens of percent at room temperature (RT) and have been applied to magnetoresistive random access memory (MRAM) and the read heads of hard disk drives. MTJs with MR ratios substantially higher than 100%, however, are desired for next-generation spintronic devices. In 2001, first-principle theories predicted that the MR ratios of epitaxial Fe/MgO/Fe MTJs with a crystalline MgO(001) barrier would be over 1000% due to the coherent tunneling of specific Bloch states. In 2004, MR ratios of about 200% were obtained for MgO-based MTJs [1]. MTJs with a CoFeB/MgO/CoFeB structure were developed for practical application and found to have MR ratios of above 200% and other practical properties [1,2].

This lecture focuses on the physics of magnetoresistance and spin-transfer torque in MTJs and the application of MTJs to various spintronic devices such as magnetic sensors, spin-transfer-torque MRAM (STT-RAM or spin-RAM) with perpendicular magnetization, and novel spin-torque oscillators [3]. In addition, new types of MTJs such as spin-filter junctions with a ferromagnetic tunnel barrier will be discussed.

[1] S. Yuasa and D. D. Djayaprawira, J. Phys. D: Appl. Phys. 40, p.R337 (2007).

[2] D. D. Djayaprawira, K. Tsunekawa, M. Nagai, H. Maehara, S. Yamagata, N. Watanabe, S. Yuasa, Y. Suzuki and K. Ando, Appl. Phys. Lett. 86, 092502 (2005).

[3] PDF file of the lecture slides can be downloaded from <http://unit.aist.go.jp/src/cie/ieee.html> with a password given at the lecture.

Freitag, 20.04.2012, 17 Uhr c.t.,

KIT, Campus Süd,

Otto-Lehmann-Hörsaal, Physik-Flachbau (Geb. 30.22).

Anschließend Nachsitzung im Gastdozentenhaus „Heinrich Hertz“