NATO Advanced Research Workshop

Functional Spintronic Nanomaterials
for Radiation Detection and Energy Harvesting

This workshop is supported by: The NATO Science for Peace and Security Programme

Spin-transfer torque devices: materials and fabrication

[1]*Andreas Kaidatzis
*lead presenter
[1]a.kaidatzis@inn.demokritos.gr, Institute of Nanoscience and Nanotechnology, N.C.S.R. "Demokritos", Athens, Greece

The building block element of modern spintronic devices is the magnetic tunnel junction (MTJ), a metal/insulator/metal stack. MTJs are thin-film multilayers in which two thin ferromagnetic layers (typically 1–2.5nm thick) are separated by a very thin (typically 1 – 1.5nm thick) insulating layer. When bias is applied across the junction, electrons cross the insulating layer due to the quantum mechanical tunneling effect; thus, the term "tunnel barrier" is used to denote the insulator. The electrical resistance of the junction in the direction perpendicular to the plane of the layers depends on the magnetic configuration of the two ferromagnetic layers, giving rise to a magnetoresistance effect. When, the two ferromagnetic layers have parallel alignment the resistance is low, whereas when they have anti-parallel alignment the resistance is high. This phenomenon is called the tunneling magnetoresistance effect. Although the materials-combination of choice for current industrial applications is CoFeB/MgO/CoFeB, this stack is reaching its limits due to the extreme miniaturization of state-of-the-art spintronic devices. In this talk, current efforts to overcome these limits will be presented, especially focusing on chemically-ordered ferromagnetic materials of the $L1_0$ crystal structure, e.g. FePt and MnAl.

Reference list

1. Andreas Kaidatzis, Georgios Giannopoulos, and Dimitris Niarchos. "Metal oxides in magnetic memories: Current status and future perspectives" in "Metal oxides for non-volatile memory", eds. P. Dimitrakis, I. Valov, and S. Tappertzhofen, 2022 Elsevier.