Abstract

In this thesis I describe the development of a new process to nanostructure a layered magnetic system. The diameter of the pillar-like structures is smaller than 200 nm. The structures are designed to allow measurements of the electrical resistance in a temperature range from ambient temperature down to 4 K. Thus, it is possible to measure the giant magneto resistance with current perpendicular to the plane of the layers (CPP-GMR) for the first time at the Forschungszentrum Jülich. Furthermore I present the first measurements of current induced magnetic switching and magnetic excitations by spin-transfer of single-crystalline iron layers.

I discuss two epitaxial systems that are prepared using molecular beam epitaxy. The first one is Fe(10) / Cr(1.2) / Fe(2) [in nm] which gives a GMR= 0.1 % at ambient temperature and 0.6 % at 4 K. By increasing a DC current the magnetic system is excited for both polarities of the current. This feature could be explained by the interlayer exchange coupling which leads to a simultaneous excitation of both iron layers. Therefore, hysteretic switching could not be observed.

The second system is Fe(14) / Cr(0.9) / Fe(10) / Ag(6) / Fe(2). The value of the CPP-GMR is around 2.6 % at room temperature and 5.6 % at 4 K. A DC current gives hysteretic current induced magnetic switching at small external magnetic fields at both polarities of the current. This observation is explained by the theoretical different signs of the spin scattering asymmetry of the Fe / Cr- and Fe / Ag interfaces. At high fields of $\sim$ 1 T only one peak in the differential resistance is observed which is a clear evidence of magnetic excitations by spin-transfer.

The observed switching indicates a very complex remagnetization process of the nanostructured system. Therefore, it is not possible to discuss the data more quantitatively. Micromagnetic simulations identify the problems of the structuring process and possible improvements are suggested.