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## Latest developments of the spin-valve transistor

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As higher recording densities lead automatically to a weaker magnetic flux above the medium, more sensitive read-head elements are required. It is expected that GMR-based heads can increase the recording density in hard disks by a factor of 4–6 within the next five years. Recently, a 5 Gbit/in<sup>2</sup> has been demonstrated by using a narrow-track inductive-write/MR-read dual element head on a low-noise Co-alloy thin-film disk [H. Mutoh et al., *IEEE Trans. Magn.* 32 (5) (1996) 3914], using the so-called current-in-plane (CIP) measuring principle. From a fundamental point of view, the CIP configuration suffers from several drawbacks; the CIP MR is diminished by shunting and channelling [B. Dieny, *J. Magn. Magn. Mater.* 136 (1994) 335; A. Fert et al., *J. Appl. Phys.* 75 (1994) 6693]. Measuring with the current perpendicular to the planes (CPP) solves most of the problems, mainly because the electrons cross all magnetic layers, but the difficulty is that the resistance of the very thin multilayers is too small to be measured by ordinary technologies. The first CPP-MR was measured by using superconductive Nb leads, consequently the device could only operate at L He temperatures [W.P. Pratt Jr., et al., *Phys. Rev. Lett.* 66 (1991) 3060]. Another device based on microfabrication technologies (multilayers etched into micropillars), the CPP was measured from 4.2 to 300 K [M.A.M. Gijs et al., *Phys. Rev. Lett.* 70 (1993) 3343]. In 1995, a new CPP-MR sensor design has been proposed by our group [D.J. Monsma et al., *Phys. Rev. Lett.* 74 (26) (1995) 5260] based on the principle of a metal-base transistor. In the so-called spin-valve transistor (SVT) a Co/Cu multilayer serves as a base region of an n-Si metal-base structure. A 215% change in collector current is found in 40 kA/m at 77 K with typical characteristics of a spin-valve effect. The device is biased to inject hot electrons from one Si layer through the multilayer, the latter magnetic configuration determining what proportion of this current eventually passes the second Schottky barrier. The latest developments will be reported about sputterbond technology and lithographic processes to reduce the dimensions of the device to make its operation at RT possible. This technology and the realisation of an SVT also establishes the feasibility of combining Si technology and spin electronics. In general, the combination of nanomagnetism (being an electrode in a device, or a magnetostatic modulation pattern) and nanoelectronics gives the possibility to realise new devices and memory functions.

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