Superparamagnetic Particle Embedded Microprobe (SPEM) for GMR Sensor Calibration

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A GMR sensor is a highly sensitive micron-sized magnetic field sensing element, whose resistance changes in response to magnetic fields. Its recent applications in biology and biomedicine emphasize the use of GMR materials as biosensors to detect the existence and the concentration of biomolecules, which were bounded to superparamagnetic particles. In order to get the relationship between the magnitude of GMR signals and the number of bounded particles, the GMR sensors need to be calibrated in advance.

The purpose of this work[1] is to establish a standard sensitivity calibration protocol for GMR (Giant MagnetoResistive) spin valve sensors using superparamagnetic particle embedded microprobes (SPEM). Comparing to other calibration methods, such as the use of MFM (Magnetic Force Microscope)[2], sealed fluidic flow cells[3], and current lines[4], the proposed SPEM method has four major advantages: no magnetic background, a precisely controlled number of particles which is mostly single-layered, pristine GMR surface after calibration, and mass fabrication.

The SPEM is made from a glass cantilever (Polymicro Technology®) and a SU-8 cylinder post (Microchem®). The superparamagnetic particles are embedded on the bottom face of the SU-8 post. By bringing a known number of single-layered particles close to the GMR surface, we could get the relationship of the GMR signals to the number of superparamagnetic particles. The probe tips were fabricated with diameters from 50µm to 200µm and a height of 500µm.

One fabricated microprobe and one calibration curve are shown in Figure 1 and 2.

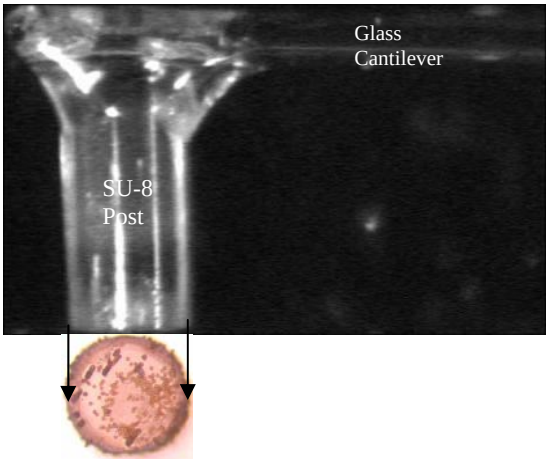

Figure 1 Fabricated microprobe and its bottom face

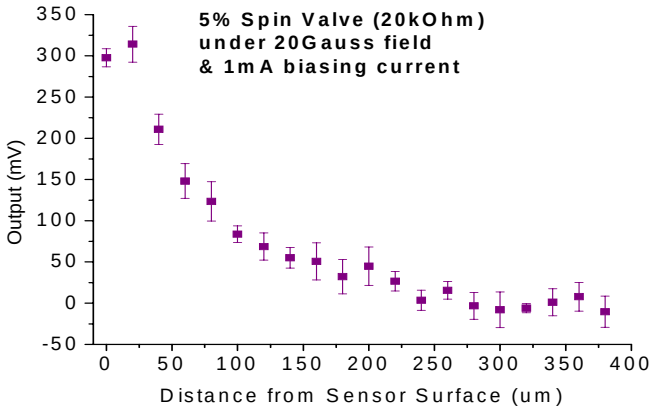

Figure 2 Distance vs GMR signal (1000x magnification)

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[1] This work is a part of BioMagnetICs (Bio-Magnetic Interfacing Concepts) program in CAMD (Center for Advanced Microstructures and Devices, Louisiana State University) supported by DARPA. GMR spin valve sensors were provided by NVE Corporation.

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[4] D.L. Graham, "Single magnetic microsphere placement and detection on-chip using current line designs with integrated spin valve sensors: Biotechnological applications", J. of Appl. Phys., vol. 91, nr. 10, p. 7786–7788, 2002