OEB Magnetics

FRIDAY May 30

Spintronic Biochips for Biomolecular Recognition

Speaker: Prof. P. Freitas, INESC Microsystems and Nanotechnologies, Physics Department, IST, Lisbon, Portugal
Time: Presentation at 1:00 PM
Cost: none
Place: Conference room in Bldg 6 (6-2202), Lawrence Berkeley National Laboratory, 1 Cyclotron Rd, Berkeley
RSVP: Please respond by email by May 21 with name, company, to Peter Fischer, PJFischer@lbl.gov so that we can prepare LBNL badges in advance for you
Web: www.e-grid.net/calendar.html#oeb-mag

Paulo Freitas is a full Professor of physics at the Instituto Superior Tecnico (IST), Lisbon, Portugal, and the director of INESC Microsystems and Nanotechnologies. His current research topics include magnetic random access memory (MRAM), read heads for ultra-high-density recording, magnetoresistive biochips, and sensors for biomedical applications. He has been involved in research in the area of magnetoresistive materials and devices since he received the Ph.D. degree in solid state physics from Carnegie Mellon University in 1986. His thesis was on anisotropic magnetoresistance of ferromagnetic thin films and alloys. He joined IBM Research, Yorktown Heights, NY, as a postdoctoral fellow working on high-temperature superconductivity and transport properties of ferromagnetic thin films. In 1988, he joined INESC, Lisbon, Portugal, where he started the Solid State Technology Group. In 1989, he became Professor of physics at the Instituto Superior Tecnico, Lisbon. From 1992 to 1996, he was responsible for the startup and operation of INESC's application-specific integrated circuit (ASIC) back-end microfabrication facility. Since 1996, his research areas expanded to magnetoresistive read elements for magnetic data storage, magnetoresistive sensors, MRAM, and biomedical applications including magnetoresistive biochips. He became director of INESC Microsystems and Nanotechnologies in 2001 and full Professor of physics at IST in 2002. Over this period, he co-authored over 200 technical papers and several book chapters. His professional activities include membership in IEEE, and participation in several publication, program, and advisory committees for the Magnetism and Magnetic Materials and Intermag Conferences.

Integrated spintronic biochip platforms are being developed for portable, point-of-care, diagnostic applications. The platforms consist of a microfluidic unit where the bioassay takes place, an arraying and detector chip consisting of target arraying current lines and integrated magnetoresistive sensors, and electronic control and readout boards. Probe biomolecules are immobilized by microspotting over sensor sites, and target biomolecules, labeled with magnetic nanoparticles, are arrayed over the probe sites (magnetically assisted hybridization). After proper washing, hybridized targets are recognized by the fringe fields created by the magnetic beads, detected by the incorporated magnetoresistive sensors. Detecting geometries using out-of-plane or in-plane bead excitation and dc or ac detection/excitation will be reviewed. Detection limits using spin valve and tunnel junction sensors will be presented, depending ultimately on platform electronic noise and sensor noise characteristics. Applications to gene expression chips (cystic fibrosis gene mutation detection) and immunoassay chips (antibody-antigen recognition; E. coli, salmonella detection) will be presented.

Spintronic biochips are also being integrated into multi-module lab-on-chip platforms including biomolecule extraction from biological fluids (magnetophoresis), polymerase chain reaction (PCR) modules (if required), and the biomolecular recognition module. Alternative spintronic biochip geometries will also be presented (lateral flow biosensors), where a magnetoresistive reader scans the surface of a porous strip where labeled target biomolecules bind to immobilized probes.

Finally, a brief review of other biomedical applications of magnetoresistive sensors will be given, from hybrid sensors targeted at biomedical imaging, to magnetic tweezers/sensors for DNA translocation monitoring.