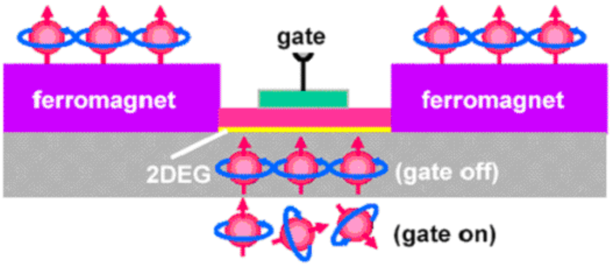
Spin-dependent transport (Modeling)

Spin electronics or "spintronics" devices is a new class of nanoscale devices which exploit both the charge and spin properties of carriers. This class of devices promises a manifold increase in processing speed and power efficiency over conventional semiconductor devices. For instance, device speed can theoretically reach the THz range of spin precessional frequency. The first generation spintronics devices such as the magnetic RAM chip, utilize "passive" spin control, in which spin filtering and spin-dependent conductivity arise from material and interfacial properties of the device. The next generation of devices makes use of active spin control in which the individual spins of carriers are controlled by electrical, magnetic and optical means. Computer simulation of spin transport is a new and rapidly developing area of research. A vast majority of present carrier transport theories and models have completely ignored the spin property, and needs to be revised substantially. At a fundamental level, we aim to develop spin transport models which can describe novel phenomenon such as spin-orbit (Rashba and Dresselhaus) effects, spin transfer torque, carrier-moment RKKY exchange in diluted magnetic semiconductor and interplay between spin and charge quantization. The models will range from simple effective mass approximation to more refined techniques of second quantized form, and non-equilibrium Green's function approach. At a more practical level, new computational models need to be developed for novel devices such as the spin-FET, spin injector, magnetic tunneling transistors, and spin qubit devices. A successful development of this model will have a significant impact in this emerging field of quantum computation.



Biomagnetics

Currently, as the interests on the personal healthcare have been dramatically increased due to the rapid developments of bio-nanotechnology sciences and engineering, the most up-to-date core researches associated with bio-medicine and relevant bio-medical engineering, which are expected to be impacted and permeated in every aspect of our lives, are being paid more considerable attentions. In order to comply with the current demands requested by both industry and academia, we, ISML research groups, are concentrated on various bio-magnetic research activities such as biomagnetism, bio-magnetic instrumentations, micro or nano-structured bio-magnetic sensors, and iron-oxide based magnetic nano-particles. For regarding to biomagnetism and its relevant research activities, our research is focused on developing new principles of bio-electromagnetic fields, which are accompanied by bioelectricity from a variety of human organs and on applying the principles to the biomagnetic instrumentations experimentally such as magnetoencephalography (MEG) and magneticardiography (MCG) etc. ISML is also currently involved in nano-structured biomagnetic sensors and bio magnetic nano-particles. For regarding to bio-magnetic sensors, DNA or RNA micro bead array counters (BARCs) using GMR & TMR effects, Antigen-antibody GMR/TMR based sensors, and in-vivo and implantable bio-magnetic pressure sensors are currently developed. For regarding to bio-magnetic nano-particle research activities, iron-oxide based magnetic nano-particles such as magnetite, co-ferrite, Ni-ferrite, and other hexagonal ferrite particles are currently considered to develop for the bio-medicine applications. Our main application targets in this research field are drug delivery and hyperthermia for killing tumor cells and for treating cancers.