SWEDISH INTERDISCIPLINARY MAGNETIC RESONANCE CENTER (SIMARC)
(http://www.ifm.liu.se/simarc)

1. *Staff*:
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   - Board:
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     Prof. Eva Lund, HU, Linköping Univ.
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     Prof. Bo Monemar, LiTH, Linköping Univ.
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   - Visting scientists:
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2. *Summary of Activities*. The research activities at SIMARC cover several areas of various disciplines, including Materials Science, Chemical Physics, Chemistry, Applied Physics, Radiation Physics and Medical Science. The materials studied include novel spintronic materials and nanostructures, advanced electronic and photonic materials such as wide bandgap semiconductors and highly mismatched semiconductors, organic materials for dosimetry and biochemical materials.

Important defect issues and recombination processes in electronic materials: The goal is, by electron paramagnetic resonance (EPR) and optically detected magnetic resonance (ODMR), to identify chemical nature and geometrical structure of defects, impurities and dopants that are important in semiconductor materials and nanostructures. The activities in this area during 2009 were focused on (i) studies of native defects such as O and Zn vacancies in as-grown ZnO; and (ii) identification of the dominant non-radiative recombination centers in Ga(In)NAs and GaNP dilute nitrides.

Spintronic semiconductor materials and nanostructures: The aim is to understand the fundamental physics underlying spin phenomena such as spin relaxation, spin injection, mechanism for spin loss, etc., so that the full potential as well as the fundamental limits of spintronics can be assessed. Within this year we have concentrated our studies on (i) understanding and optimization of our recently discovered defect-engineered spin filtering effect in Ga(In)NAs quantum and nano structures; (ii) spin injection dynamics and mechanism in ZnMnSe/CdSe quantum dot structures; and (iii) spin dynamics in ZnO-based materials; and (iv) optical spin injection in InAs quantum dots.

Development of spin-sensitive local probe microscopy/spectroscopy: The aim is to develop a variety of advanced spin-sensitive scanning probe microscopies (SPM) and to apply them to studies of nano-magnetism and spin detection and manipulation on the nano- and atomic scale in novel electronic and magnetic materials and nanostructures.

EPR dosimetry: The aim of the research within this project is to improve EPR dosimetry (ionising radiation dose measurements) to be a competitive dosimetric method for applications in radiation therapy. We are working with the optimization of measurement precision and accuracy in dose measurements by the development of new dosimeter read-out protocols and dosimeter calibration protocols. We are also searching for new dosimeter materials with higher sensitivity and better tissue equivalence with respect to attenuation and scattering of ionizing radiation. We are currently clinically evaluating a lithium formate EPR dosimeter system for dosimetry in special measurements situations such as dosimetry in intensity modulated radiation therapy (IMRT) and brachytherapy.

Retrospective dosimetry by means of EPR spectroscopy: EPR spectroscopy measurements of chewing gums and sweeteners sorbitol and xylitol have been performed in order to optimize the use of them as retrospective dosimeters. Radical identification, transitions, stability, dose response and light dependence have been investigated. Retrospective dosimetry on tooth enamel has also been performed through participation in an international tooth comparison study.

3. *Highlights*:

- *Dominant recombination centers in Ga(In)NAs alloys: Ga interstitials*

We have provided unambiguous experimental evidence that the defects involving Ga_i are the common grown-in defects in Ga(In)NAs alloys regardless of the growth methods employed for material fabrication ranging from gas-source molecular beam epitaxy (MBE), solid-source MBE, to metal-organic chemical vapor deposition (MOCVD). They act as efficient NRR centers which control carrier lifetime and degrade optical quality of the alloys. The defects formation is concluded to become thermodynamically favorable under the presence of N, possibly because of local strain compensation. (Appl. Phys. Lett. 95 241904 (2009))

- *Evaluation of a lithium formate EPR dosimetry system for dose measurements around ^{192}Ir brachytherapy sources*

A lithium formate EPR dosimetry system was used for measurements of dose distributions around clinical ^{192}Ir brachytherapy sources. Experimentally measured doses agreed well with the doses calculated by the treatment planning system (TPS) within ± 2.9 % and uncertainty in dose measurements was estimated to 1.3 % to 1.7 % (k=1.96). This study therefore showed that the low energy dependence and wide dynamic range of linear dose response of lithium formate EPR dosimeters, as compared to commonly used thermoluminescence dosimeters (TLD). This makes them well suited for dose measurements in situations where energy dependence cannot be easily accounted for e.g. around clinical brachytherapy sources. However, for clinical use in single source dosimetry it would be useful if the size of the dosimeters could be further reduced for improved spatial resolution in the dose measurements. (Medical Physics 36 2236-2247 (2009)).

4. *Collaborations*: About 30 research groups from Europe, USA and Asia are in active collaboration with SIMARC.

5. *Others:*

Håkan Gustafsson has been awarded an assistant position by the Swedish Research Council. The project title is "Medical applications of electron paramagnetic resonance imaging". The project has the aim to use EPRI for imaging of radicals in biological samples such as atherosclerotic plaques and imaging of dose distributions for applications in radiation therapy. (*http://vrproj.vr.se/detail.asp?arendeid=71224*).