Master Thesis

MICROMAGNETIC SIMULATIONS FOR THE DESIGN OF AMR-BASED SENSORS

Background – Sensor system and Micromagnetism:

Magnetic sensor systems are used to measure observables of interest through magnetic field detection. The aim of this project is to develop a magnetorestive gas sensor consisting of magnetic nanoparticles (metal oxides - MOx) – reacting with volatile organic compounds (VOx, i.e. water, ethanol) - and a ferromagnetic thin film that plays the role of magnetic field sensor exploiting the so-called anisotropic magnetoresistance (AMR) effect.

The design of the sensors is mainly done by micromagnetic simulations and computer experiments that solve the Landau-Lifshitz-Gilbert equation and attempt to calculate the static magnetic properties of the system. One major problem when designing realistic ferromagnetic structures consists in dealing with the large number of variables that describe the geometry and the material parameters. In the field of the micromagnetism, the variation of the system properties is a challenging topic.

Thesis:

The goal of this thesis is to use micromagnetic simulations and analytical model to investigate the behavior of the magnetic nanoparticles and to design an AMR sensor with extremely high sensitivity. Various geometrical shapes and ferromagnetic systems can be taken into account to enhance the AMR effect in the ferromagnetic sensor. To this end, multiple micromagnetic simulations are necessary to investigate the ground state of the magnetization according to the LLG equation. The student is expected to take over the tasks of studying and comparing the magnetization configuration via micromagnetic simulations for different values and directions of the applied magnetic field.
In summary, we offer to teach about magnetism, magnetic sensor systems, simulations and micromagnetism. We expect willingness to learn and apply this knowledge. The proposed research work also holds the potential to generate peer-reviewed scientific publications and contributions to international conferences.

About us:

Silicon Austria Labs (SAL) is on the way to become a top European research center for electronic based systems. In the network of science and industry, we carry out research at the highest global research level and thus create the basis for new types of products and processes. SAL is divided into four divisions: Sensor Systems, RF Systems, Power Electronics and System Integration. It is endowed with state-of-the-art facilities, consisting of comprehensive optical labs, C5/C8 cleanroom facilities, back-end processes for micro-packaging, as well as custom prototyping facilities (custom electronic development, 3D printers, CNC-machinery, Inkjet printer).

Start Date / Duration / Contract:

Start date (planned): as soon as possible
Duration (planned): 6 Months
Payment: 1385€ gross (38.5 Hours/Week)

Place: Villach, Austria

Profile / requirements:

- Background in physics, nanoscience, simulations, magnetic materials
- Ideally experience with scientific finite elements or finite difference methods
- Interest to learn about magnetism, microsystems and magnetic sensors
- Ability to work independently AND in a team
- High level of English

Contacts

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Master Thesis

SET-UP DEVELOPMENT FOR MAGNETIC SENSOR TESTING

Background – Sensor system and Micromagnetism:

Magnetic sensor systems are used to measure observables of interest through magnetic field detection. Our recent work has been devoted to the design and fabrication of magnetic sensors based on the so-called anisotropic magnetoresistance (AMR) effect, i.e., on the electrical resistance change of a ferromagnetic material depending on the angle between the direction of the electrical current and the direction of magnetization.
The design of the sensors is mainly done via micromagnetic simulations and computer experiments that solve the Landau-Lifshitz-Gilbert equation and attempt to calculate the static magnetic properties of the system. The sensor manufacture relies on state-of-the-art microfabrication techniques, including patterning via laser lithography and deposition of thin-film magnetic materials by means of PVD techniques.
The aim of our strategic research is now focused on the development of magnetic gas sensors consisting of AMR devices (acting as magnetic field sensors) suitably functionalized with magnetic nanoparticles (which react with the gas molecules).

Thesis:

The Master's thesis activity will be focused on the development of experimental platforms suitable for the characterization of our AMR-based gas sensors.
The Master's student is expected to assemble and put into operation a set-up for the execution of electrical measurements within an environment with gas-controlled flow. This platform will be employed for the experimental characterization of our novel gas sensors based on the functionalization of AMR devices.
In addition, the student is expected to work on the design and assembly of a custom Helmholtz coil system allowing to generate a 3D magnetic field for the characterization of our AMR sensors via magnetoresistive measurements. Eventually, part of the work may consist in the integration of a properly designed gas cell within the Helmholtz coil system.
We offer to teach about magnetism, magnetic sensor systems as well as experimental characterization tools and techniques. We expect willingness to learn and apply this knowledge. The proposed research work also holds the potential to generate peer-reviewed scientific publications and contributions to international conferences.

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Start Date / Duration / Contract:

Start date (planned): as soon as possible
Duration (planned): 6 Months
Payment: 1385€ gross (38.5 Hours/Week)

Place: Villach, Austria

Profile / requirements:

- Background in physics, nanoscience, magnetic materials
- Programming skills (e.g., Python)
- Experience with electronic instrumentation is beneficial
- Interest to learn about magnetism, microsystems and magnetic sensors
- Ability to work independently AND in a team
- High-level command of the English language (both written and oral)

Contacts

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