Master Thesis Topic

Simulation of Acoustically Driven Magnetization Dynamics in Ferromagnetic Multilayers

Background and Motivation

The efficient manipulation of magnetic nanostructures is fundamental for high-capacity memory, computing, and magnetic sensing applications. Conventional manipulation techniques based on magnetic fields and electric currents typically cause energy dissipation and limit miniaturization. In contrast, strain-based magnetization control is a promising alternative that can lead to fast, compact, and energy-efficient devices.

Over the past decade, surface acoustic waves (SAWs) have emerged as an ideal tool for manipulating magnetization. SAWs are elastic waves traveling along the surface of a solid that can modulate the properties of thin magnetic films via magnetoelastic and magnetorotation coupling. Of special interest are epitaxial thin films such as Fe_3Si or Fe-Ge-Te compounds due to their high crystalline quality and low magnetic damping, thus enabling a fast and efficient response to the dynamic strain of SAWs.

Objective

The aim of this project is to investigate the magnetization dynamics of epitaxial multilayers under SAW strain fields. The key objectives are:

1. **Developing a code for micromagnetic simulations:** Write and test a code to simulate the magnetization dynamics of epitaxial multilayers under the time and spatially dependent strain field of SAWs.
2. **Optimization of the interaction between SAW and magnetization**: Systematic study of the magnetization dynamics in the epitaxial multilayers under several film thicknesses, magnetization directions, magnetic anisotropies and types of applied dynamic strain.

Methodology

During the project, your tasks will include:

1. Learn the principles of micromagnetic simulations and the programming language of the mumax^3 simulation software.
2. Perform numerical simulations to determine the spatial magnetization distribution and ferromagnetic resonance frequencies in multilayer thin films.
3. Numerical analysis of the magnetization dynamics in multilayer thin films driven by the dynamic strain of SAWs.

Expected Outcomes

The expected main results of the project are:

- Determination of the optimal frequencies for the efficient coupling of SAWs to the magnetization in epitaxial multilayers.
- Detailed understanding of the effect of SAWs on the magnetization dynamics of such multilayers.

Skills and Requirements

- Background in solid state physics, materials science, or related fields.
- Experience or interest in numerical simulations and magnetism.
- High motivation, excellent interpersonal and project management skills.

Opportunities and Benefits

- Supportive environment with experts for various scientific sub-fields.
- International and culturally diverse community.
- Location in the heart of Berlin with excellent public transport connections.
- Subsidized travel ticket.

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For further details or clarification, please feel free to contact us. Lab tours are also available for interested applicants.