Multi-physics magneto-mechanical properties of short fiber reinforced composites

Background: Composite materials are being increasingly used in different industries due to their lightweight characteristic and superior mechanical performance (compared to e.g. neat polymers). Short fiber composites are a branch of these materials in which matrices are reinforced with short fibers. Some of short fiber composites are made using fibers which possess magnetic properties. These materials, due to their controllable and reversible mechanical performance under external magnetic field, have become interesting for aerospace and automotive industries among others [1]. In this project, we would like to model the multi-physics (mechanics-magnetics) behavior of these materials.

Project description: Due to large number of microscopic properties (e.g. fiber volume fraction, fiber orientation distribution, magnetic properties of fibers etc.) it is necessary to use micro-mechanical models where the effects of these parameter are considered. One of the modeling approaches which has gained considerable attention from composite community is multi-scale computational homogenization. In this approach, a Representative Volume Element (RVE) is developed which represents the micro-structural characteristics of the composite material. The macroscopic stress and strain are obtained as the volume average of the microstructural stresses and strains. An RVE of a short fiber composite and its spatial discretization are shown in Figure 1. In this project, we will use software COMSOL to model the effects of different microscopic properties on the macroscopic behavior in terms of mechanical and magnetic properties.

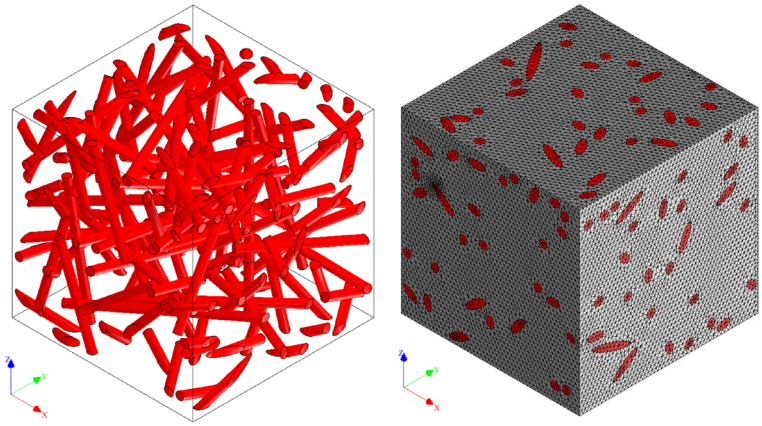

Figure 1: A Representative Volume Element (RVE) of a short fiber composites and its Finite Element spatial discretization [2].

Method: The project will consist of computer simulations using the software COMSOL.

Group size: 3-6 students

Student background: This project is suitable for a group of students interested in computational physics. Familiarity with software COMSOL is big plus, but not a necessity.

References:

[1] Zhang et al. (2020) Composite Science and Technology 191: 108079.

[2] Mirkhalaf et al. (2020) Composites, Part B 202: 108388.

Contact/supervisors:

Mohsen Mirkhalaf, Department of Physics, University of Gothenburg, mohsen.mirkhalaf@physics.gu.se
Martina Ahlberg, Department of Physics, University of Gothenburg, martina.ahlberg@physics.gu.se