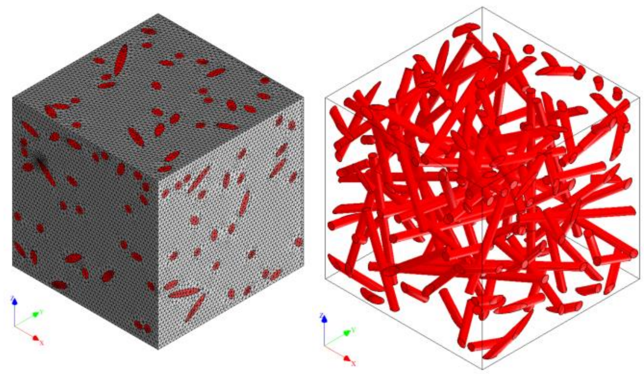
TIFX04-23-32

Thermal conductivity 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. Fabrication processes of these materials typically result in anisotropic mechanical, electrical, and thermal properties. In this project, we will investigate thermal conductivity of short fiber composites considering their microstructural properties.



A Representative Volume Element (RVE) of a short fiber composite and its Finite Element spatial discretization.

Problem description:

Thermal conductivity is one of important properties of materials. Due to large number of microscopic properties (e.g., fiber volume fraction, fiber orientation distribution, thermal properties of fibers and matrices) it is necessary to use micro-level models where the effects of these parameter are considered. In this project, we will use different micro-level models to analyze thermal conductivity of short fiber composites. As opposed to many studies in which thermal conductivity is considered as a scalar parameter, we will model thermal conductivity as a direction-dependent parameter and hence, a second-order tensor will be considered.

Methodology:

One of the modeling approaches which has gained considerable attention from composite community is computational homogenization. In this approach, a Representative Volume Element (RVE) is developed which represents the micro-structural characteristics of the composite material. Finite Element Method (FEM) is typically used for solving the problem and obtaining the homogenized effective properties. This is a very accurate method but there are challenges too: (i) the computational cost of this modelling approach could be very high, (ii) it is not always straightforward to generate RVEs which mimic the actual material micro-structure. An alternative approach is to use mean-field models in which average quantities are considered in individual phases of a micro-structure. In these modelling approaches, typically, explicit analytical relations are obtained for the average response of a micro-structure. We will use both methods in this project. The thesis and presentation can be in Swedish.

Group size: 3-6 students

Target group: F, GU-fysik, TM or equivalent

Literature:

[1] DOI: 10.3390/polym14163360 ; [2] DOI: 10.1016/j.compositesb.2020.108388

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