Efficient Simulation of Short Fibre Reinforced Composites

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Lightweight structures became more and more important over the last years. One special class of such structures are short fibre reinforced composites, produced by injection moulding. To avoid expensive experiments for testing the mechanical behaviour of these composites proper material models are needed. Thereby, the stochastic nature of the fibre orientation is the main problem.

In this talk we look onto the simulation of such materials in a linear thermoelastic setting. So, we use the stress-strain relation

$$\sigma = \mathfrak{C} : (\varepsilon - (\theta - \theta_0)\mathbf{T}), \tag{1}$$

with a fourth order material tensor $\mathfrak{C}$, a second order thermal expansion tensor $\mathbf{T}$, the temperature difference $(\theta - \theta_0)$, and the second order linearised strain tensor ε.
The needed material properties can be described by averaging the material properties of transversely isotropic materials. In this talk we will present how this can be done in an intuitive way. We also show, how these idea can be used for the description of the arising stresses within such composites.
Furthermore, we look onto equation (1) in a time dependent setting, i.e. θ is described by

$$c_\rho \rho \frac{\partial \theta}{\partial t} - \nabla(\kappa \cdot \nabla\theta) = \Theta,$$

with the material density ρ, the specific heat capacity c_ρ and the symmetric second order heat conduction tensor κ. Here, κ also depends on the stochastic fibre orientation. For this setting, we will present some numrical results.

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