INTERDISCIPLINARY CENTRE FOR
ADVANCED MATERIALS SIMULATION

MMM Seminar

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Thursday, February 18, 10:00 a.m.
ICAMS Seminar room UHW 11/1102

Concept and Applications of the Multiscale FEM

This presentation is concerned with the concept and application of the multiscale finite element method, resulting from a combination of the homogenization theory and the theory of the finite elements. The method is used to simulate the behavior of a macroscopic body with material properties defined by the geometry and structure of a representative volume element (RVE) and is suitable for cases where the ratio of the characteristic lengths of the scales tends to zero. The property making this method attractive, is that it can be applied to nonlinear composite materials and finite deformations without greater difficulties. The presentation explains three examples in detail.

The first example simulates the behavior of microporous nonlinear material. Here, a tension test of a plate is considered at macroscale, while a square RVE with an elliptical pore is chosen to describe the material properties. Given a random microstructure, the RVE is assumed to have a different orientation in each Gauss' point.

The second example looks at modeling solution-precipitation creep, which is a diffusional process occurring in polycrystals if pressure and temperature are in the specific range. For this problem, a continuum-mechanical model is proposed where the deformation is decomposed into an elastic and an inelastic part and the total power is written as a superposition of total elastic power and dissipation.

The motivation behind developing the model for the RVE of cancellous bone, which is the last example, is to investigate the process of osteoporosis, whose main indicators are the decrease and partial disappearance of the solid phase. The important feature of the model is that the presence of the fluid phase necessitates dynamic interrogation and analysis in the complex domain.