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PHASE-FIELD MODELLING OF STRESS EVOLUTION IN HETEROGEN STRUCTURES

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Computational models based on the phase-field method typically operate on a mesoscopic length scale resolving structural changes of the material and provide valuable information about microstructure and mechanical property relations. An accurate calculation of the stresses and mechanical energy at the transition region is therefore indispensable. We derive a quantitative phase-field elasticity model based on force balance and Hadamard jump condition at the interface. Comparing the simulated stress profiles in a plate with a round inclusion under hydrostatic tension with the theoretical predicted stress fields and stress field calculated with Voigt/Taylor [1] and Reuss/Sachs [2], we show the quantitative characteristics of the model. In order to validate the elastic contribution to the driving force of the phase transition, we demonstrate the absence of interfacial excess energy, calculated by Durga et al. [3], in one dimensional equilibrium condition of serial and parallel material chain.

In order to calculate the plastic strain, the Prandtl-Reuss model is implemented consisting of an associated flow rule in combination with the von Mises yield criterion and a linear isotropic hardening approximation. Simulations are performed illustrating the evolution of the stress and plastic strain using a radial return mapping algorithm for single phase system and heterogeneous microstructures, pictured in Figure 1.

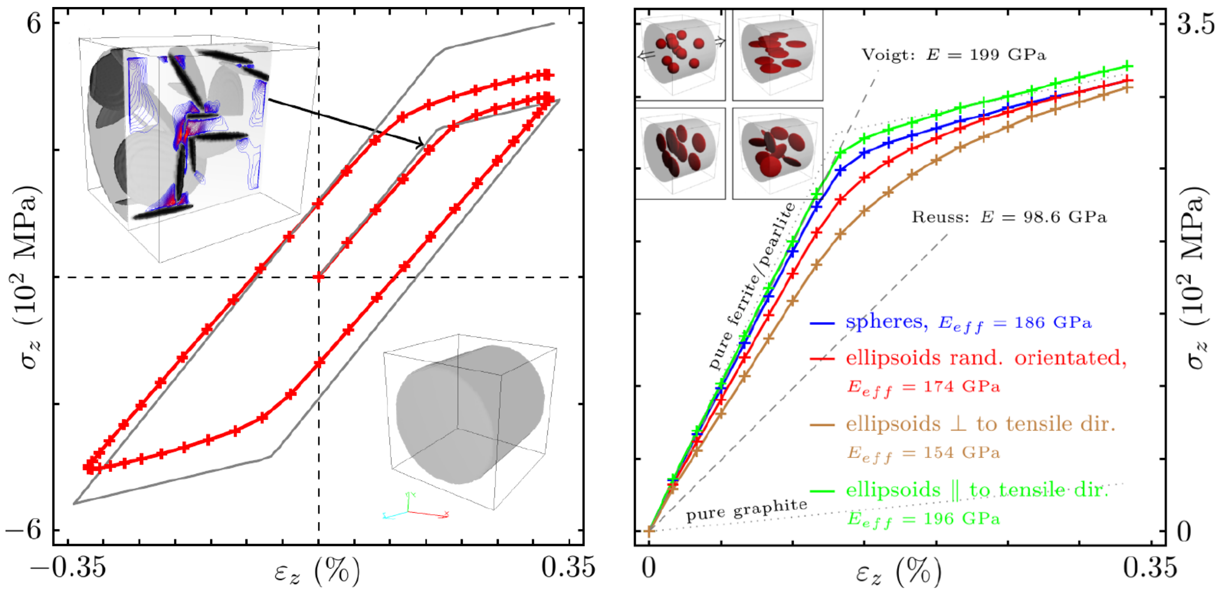

Figure 1: left: Stress-strain curves of cyclic loading simulations. Comparison of hystereses related to homogeneous (gray) and heterogeneous (red) material. right: Resulting stress-strain curves of heterogeneous microstructures with different configuration in a cylindrical simulation domain. [4]

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