Homogenization methods for anisotropic linear elastic polycrystals

T. Böhlke, K. Jöchen, T.-A. Langhoff

Chair of Continuum Mechanics, University of Karlsruhe (TH),
Kaiserstr. 10, 76131 Karlsruhe, Germany

The elastic properties of uniform polycrystalline materials without defects depend on both the constitutive properties of the constituents and the microstructural characteristics like the distribution of grain orientations and grain shapes. For an overview concerning the homogenization of elastic properties see, e.g., [1]. The elementary bounds by Voigt and Reuss take into account only the volume fraction information of microstructure and hence are insensitive with respect to any morphological aspects of the grain structure.
In the presentation we discuss new anisotropic Hashin-Shtrikman bounds for aggregates of cubic and hexagonal crystals. In the case of anisotropic crystallographic symmetry and isotropic morphology, an explicit form is obtained which is nonlinear in the texture coefficients. For anisotropic morphology however, the result is obtained only numerically and shows a significant influence of two-point correlation function. Furthermore, we derive a new higher-order estimate of the effective elastic properties in terms of tensorial one-point and two-point correlation functions for the special case of uncorrelated grain shapes and grain orientations [2]. Based on the integral equation formulation, a series expansion for the effective elastic properties is used as starting point [3]. We especially consider the coupling terms that arise due to the interaction of the inhomogeneous distribution of crystal orientations and non-equiaxed grain geometry. The new bounds and estimates are used for prediciting the effective and apparent properties of metals and ceramics.

References

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