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ELASTIC PROPERTIES OF DILUTE SOLID SUSPENSIONS WITH IMPERFECT INTERFACIAL BONDING: VARIATIONAL ESTIMATES VERSUS FULL-FIELD SIMULATIONS

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Abstract. Many energetic solids of technological interest are aggregates of micrometric particles or grains cemented together by a compliant binding phase. Prominent examples include polymer-bonded triaminotrinitrobenzene and cyclotetramethylene-tetranitramine. Despite occupying a low fraction of the total volume, the binding phase can play a central role on the overall thermomechanical behavior and sensitivity of the solid. This is because irreversible phenomena such as viscous deformations and damage evolution occur mostly within that phase as a result of the granular morphology and local thermomechanical contrast. In high-energy systems the intergrain spacing is much smaller than the grain size, the binding phase can be regarded as an interphase of vanishing thickness, and the aggregate can be conceived as a microstructured solid with imperfect intergranular bonding exhibiting hereditary behavior. Mean-field descriptions of such material systems often rely on estimates for dilute solid suspensions with imperfect interfacial bonding exhibiting linearly elastic behavior. Several strategies to produce such estimates with varying degrees of generality and rigor have been pursued in the literature. In this presentation we expound a variational procedure to generate estimates that reproduce exact results for weakly anisotropic but otherwise arbitrarily large interface compliances, and will easily accommodate interfacial dissipative processes in a thermodynamically consistent manner. The estimates allow for arbitrary elastic anisotropy of the constitutive phases but are restricted to spherical geometry of the inclusions. Reference results are also produced via a Fast-Fourier-Transform algorithm applied to periodic distributions of spherical inclusions coated with a thin interphase with suitably chosen properties. Special care is taken to generate geometrically smooth spheres devoid of the surface stairs commonly originated by the regular Fourier grid. These reference results are used along with exact results available for sliding inclusions to assess the variational estimates relative to estimates based on modified Eshelby tensors. The presentation concludes with an overview of ongoing work on mean-field descriptions for granular solids.