Continua models with strain gradient energy obtained by rigorous homogenization

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In the framework of homogenization of high contrast materials, we study the effective behavior of periodic elastic structures. We focus our attention to determine the effective energy of lattice-based periodic structures. The geometry we consider is based on periodic graph which is determined by:

- a bounded open domain Ω in $\mathbb{R}^n$, $n = 2$ or 3,
- a prototype cell containing a finite number of nodes,
- a family of two (in 2D) or three (in 3D) independent periodicity vectors,
- five (in 2D) or fourteen (in 3D) interaction matrices defining the edges of the graph.

The considered structures can be modeled by a system of nodes liked by extensional, flexional and torsional bars. We use the method of Gamma-convergence to study the equilibrium of the structures. We show that when the small parameter ε which compares the size of the periodic cell with the size of the macroscopic domain Ω tends to 0, the initial elastic energy converges (in the sense of Gamma-convergence) to a nonlocal strain gradient energy with possible extra kinematics variables (see [1], [2]).
We provide the general algorithm [2] which makes explicit the effective energy and the effective stiffness matrices. If the infimum with respect to the extra kinematic variables cannot be computed locally, we use Matlab/Octave and Maxima software to do it.
Our future work will be the optimization of our structures for getting experimental evidence of second gradient effects.

Références

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