Homogenization of cellular solids for magneto-elastic properties.

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Smart magnetostrictive materials transform magnetic energy into mechanical energy and can be used as actuators. In magnetic shape memory alloy (MSMA) larger strains can be obtained, compared to conventional Joule-based magnetostrictive (JMS) materials, due to magnetic field-induced crystallographic changes. However, the strains obtained by MSMAs are still very small, due to the mismatch in crystal orientation between neighboring grains. Two recent developments have led to a profound increase in strains which enhanced the potential of magnetostrictive actuators considerably. First, the introduction of porosity has been shown to alleviate the constraints imposed by the mismatch between grains, leading to much larger strains in MSMA materials [1]. Similarly, bonded metal fibre networks have been demonstrated to generate appreciable strains with modest magnetic fields [2]. Second, polymeric materials containing magnetic nanoparticles have a much larger magneto-mechanical compliance than the conventional metallic systems and thus generate much larger strains, especially in low-dimensional configurations as beams and shells [3]. These two recent developments open the door for new applications, by exploiting the large magnetocompliance of highly-porous magnetic actuators.

Starting from a continuum formulation, we have recently developed a methodology to estimate the deflection and demagnetization field for a slender object in a uniform external magnetic field. We want to extend our developed model to simulate 2D regular hexagonal lattices and general 3D cellular solids. To do so, we will develop a homogenization method for the magneto-elastic properties of cellular solids.

References

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