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THE MECHANICS OF MULTI-PHASE LATTICES

Norman A Fleck

Cambridge University Engineering Dept., UK

Abstract. Traditionally, lattice materials comprise a micro-architectured lattice and intervening porosity. The mechanical properties are sensitive to the topology, relative density and the length scale, but usually much less sensitive to the degree of imperfection. But what if we fill the porosity with an inviscid, incompressible fluid? The resulting mechanical properties are sensitive to the degree to which fluid can leak from one cell into the next. The macroscopic in-plane yield surface of a hexagonal honeycomb, filled with such an inviscid, incompressible fluid, has been calculated and analytical models have been obtained for the collapse modes. Numerical simulations reveal that the finite strain response can comprise a snap-back, softening behaviour under uniaxial compression. This has been explored in some details, and the transverse propagation of a shear band, and its subsequent band broadening is reminiscent of microbuckle propagation in a fibre composite. A Maxwell-line construction can be used on the unit cell response in order to determine the steady state propagation stress. Other competing collapse modes exist that exhibit string softening but do not admit the existence of a localisation (shear) band. If time permits, some remarks will be made on the actuation of a lattice due to induced swelling by the presence of a liquid phase.