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Finite deformation of thin-wall composite spheres

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Thin-wall composite spheres (TWCSs) are very common in both natural and man-made structures. We examined the mechanical response of incompressible TWCSs, which were investigated in the past almost solely at the limit of infinitesimal deformation elasticity, within the framework of finite deformation elasticity. Specifically, we consider TWCSs with a neo-Hookean core phase and a stiffer or a softer shell subjected to general homogeneous isochoric displacement or traction boundary conditions. We derived the general forms of the displacement and the pressure fields in both phases in terms of a power series about the shear and the stretch magnitudes. The predictions of the analytical solutions were analyzed and compared with corresponding results of finite element simulations of TWCSs. We found that a relatively small number of terms in the series are required for a good agreement with the numerical simulations. Specifically, eight terms are needed when considering the local fields up to a stretch ratio of 150%, or when considering the average fields up to a stretch ratio of 300%. At the micro-level we found interesting similarities between the spatial distributions of the stresses among the different cases of TWCSs with a stiffer shell and TWCSs with a softer shell, under displacement BC and under traction BC. At the macro-level we found that while the stored strain energy is identical in TWCSs subjected to identical magnitudes of strain or nominal stress under both types of boundary conditions, a poynting effect is observed in the finitely deforming TWCSs.

Biography

Gidon Weil is pursuing his PhD degree under the supervision of Prof. Gal deBotton at the Department of Mechanical Engineering, Ben-Gurion University of the Negev. He has a BSc in Physics (Magna cum Laude, 2012) and Mechanical Engineering (Summa cum Laude, 2012), and MSc in Mechanical Engineering (Summa cum Laude, 2014). He is currently interested in estimate solutions for finitely-deforming particulate composites, at the macro-scale, and exact solutions for the finitely-deforming thin-wall composite sphere micro-structure.

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