Novel Properties of Composite Gel Material and Structures Induced by the Buckling Instabilities

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The novel gel composite structures with arrays of rectangular or circular particles will undergo sudden structural transformation at a critical strain when subjected to internal compressive stresses. This type of structures is able to exhibit some unusual mechanical properties, such as auxetic behavior owing to the local elastic instabilities. In this paper, the special mechanical properties of the proposed composite gel material and structures are investigated using simulations and theoretical analysis. In order for the pattern transformation to be induced by buckling instabilities, the detailed design of gel structure patterns and composite materials are optimized. When stress level reach the critical elastic limit of structure, the narrow ligaments between the particles in composite structure will buckle, thus resulting in the hyperelastic behavior of the composite gel structure. According to this buckling mechanism, the control over the mechanical instabilities in periodic composite material can be used in the potential application of new material and structures design.

Keywords: Instabilities; Composite gel material; Periodic structures; Mechanical behavior.