Buckling guided assembly of flexible 3D structures and electronics based on engineered dielectric elastomer platform

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Abstract

Recently developed approaches of mechanically-guided assembly allows the deterministic formation of complex three-dimensional (3D) mesostructures in a broad set of functional materials, over length scales from nanometers to centimeters. Previous studies mostly exploited homogenous elastomer substrates, in which the deformations are uniform and controlled mechanically, thus limiting the capability to reshape into different 3D configurations. This work introduces a set of design concepts using dielectric elastomer actuators (DEA) as the 3D assembly platforms, which could offer independently controlled, sequential, local deformations of the substrates. Quantitative experiments and numerical simulations illustrate the capabilities of the dielectric elastomer (DE) platform in achieving complex deformation characteristics, e.g., tunable deformable field via multiple individually addressable electordes, isolation of strain field and high loading speed. Demonstrations include nearly 30 examples, including morphable 3D structures, froglike structure, eyeglass-like structure, starfish-like structure, and 3D structures that resemble Beijing National Sports Center. A tunable inductive-capacitive (LC) radio-frequency (RF) circuit consisting of a morphable 3D capacitor serves as an application example.