An excursion into the design space of biomimetic architectured biphasic actuators

Abstract

Natural hygromorph actuators, such as those found in the pine cone or in the awns of wheat and the storksbill, achieve a large variety of motions by controlling the distribution of swellable tissues inside their geometries. Such natural systems provide inspiration for the design of artificial actuators where swelling is triggered by any external expansion field. One way to achieve differential swelling inside a structure is to consider two elastic phases with different expansion properties and to apply a uniform expansion field. The resultant motion depends on the geometric distribution of the two phases and the cross-section of the structure. This paper uses the finite element method to explore how the geometry and symmetry of the initial structure controls the range of motion available.

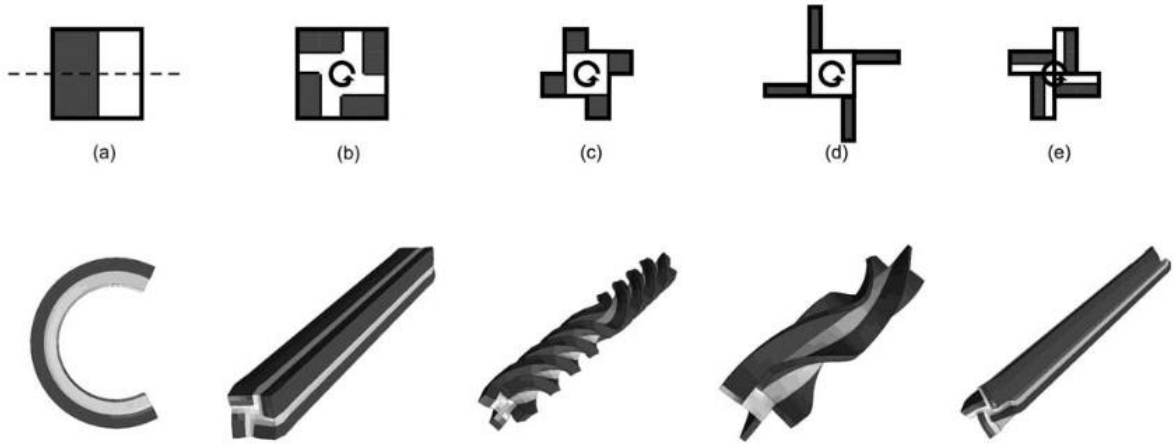

Fig. 3. Simulated actuation patterns for several cross-sections with passive/active area ratio of 50 : 50: (from left to right) (a) Classical bilayer bending in its mirror plane; (b) Closed 4-fold cross-section with bilayer RUC remains straight; (c) Opened 4-fold cross-section with bilayer RUC shows huge twisting; (d) Opened 4-fold cross-section with bigger moment of inertia shows less twisting than (c). (e) Opened 4-fold cross-section with differently oriented bilayer RUC remains straight.