Abstract

Active solids consume energy to allow for actuation, shape change, and wave propagation not possible in equilibrium. For two-dimensional active surfaces, powerful design principles exist that realise this phenomenology across systems and length scales. However, control of three-dimensional bulk solids remains a challenge. Here, we develop both a continuum theory and microscopic simulations that describe an active surface wrapped around a passive soft solid. The competition between active surface stresses and bulk elasticity leads to a broad range of previously unexplored phenomena, which we dub *active elastocapillarity*. In passive materials, positive surface tension rounds out corners and drives every shape towards a sphere. By contrast, activity can send the surface tension negative, which results in a diversity of stable shapes selected by elasticity. We discover that in these reconfigurable objects, material nonlinearity controls reversible switching and snap-through transitions between anisotropic shapes, as confirmed by a particle-based numerical model. These transition lines meet at a critical point, which allows for a classification of shapes based on universality. Even for stable surfaces, a signature of activity arises in the negative group velocity of surface Rayleigh waves. These phenomena offer insights into living cellular membranes and underpin universal design principles across scales from robotic metamaterials down to shape-shifting nanoparticles.

Active elastocapillarity

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