Supporting Information

Buckling of Elastomeric Beams Enables Actuation of Soft Machines

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Fabrication of buckling actuators

We designed the molds using computer-aided design (CAD) (Solidworks) and fabricated them using a 3D printer (StrataSys Fortus 400mc). The molds, made of acrylonitrile butadiene styrene (ABS) plastic, were filled with a silicone-based elastomer (Ecoflex 0030) for at least 3 hours at room temperature (Figure S1). The buckling actuator is cast in two half structures and bonded together using uncured Ecoflex 00-30 in a 60 °C oven for 10 minutes. To interface with the actuator, we bonded a conically shaped elastomeric piece to the side of the buckling actuator to provide additional material for a tubing/air-duct to be attached (the extra conical piece prevents undesired leaking of air).

Measurement of lifetime

We measured the lifetime of three single-unit buckling actuators fabricated in Elastosil by connecting them to an Arduino controlled/gated pneumatic source. The buckling actuators were each fully deflated and then re-inflated to the initial state repeatedly.

The buckling actuators were actuated at a frequency of 2Hz, and left running continuously for 5 days 19 hours, which resulted in more than 1000000 cycles of actuation. We tested the rotation angle vs. applied negative pressure of these three actuators, and no significant change in the curves was observed (Figure S9).

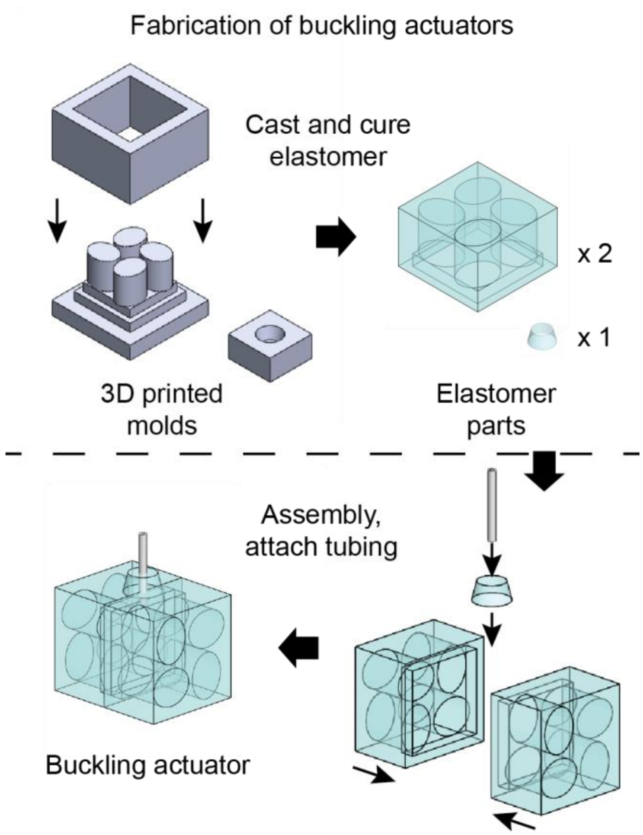

Figure S1. Fabrication of buckling actuator.

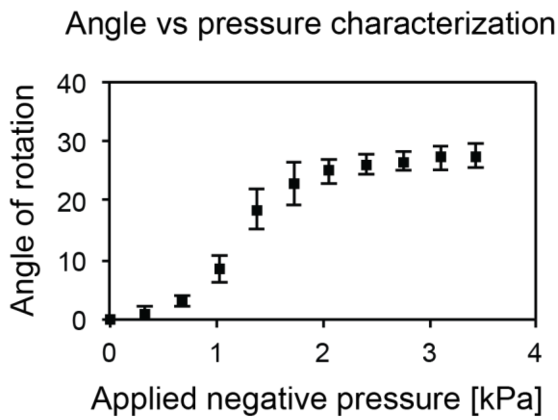

Figure S2 Angle of rotation vs. Applied negative pressure curves of a single-unit buckling actuator (1 atm = 100 kPa).

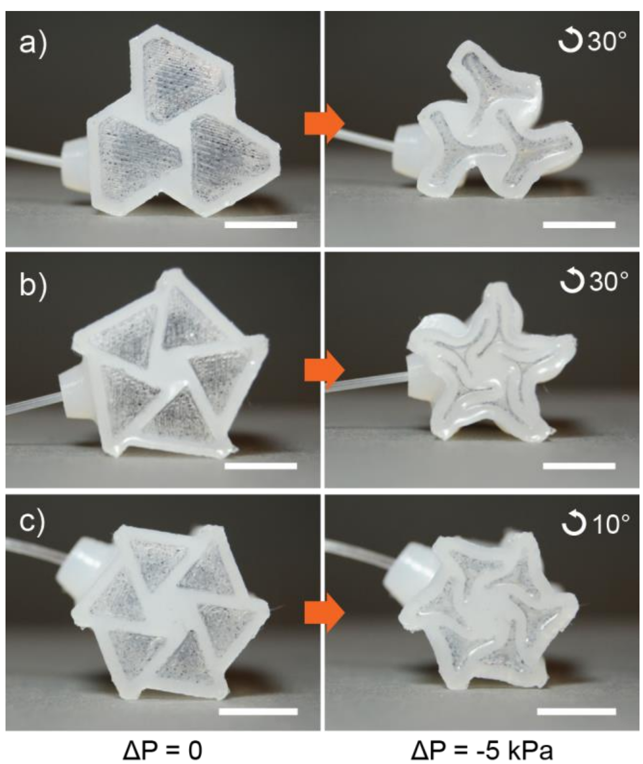

Figure S3. Examples of more buckling actuator geometries with different numbers of pillars. Scale bars are 1 cm.

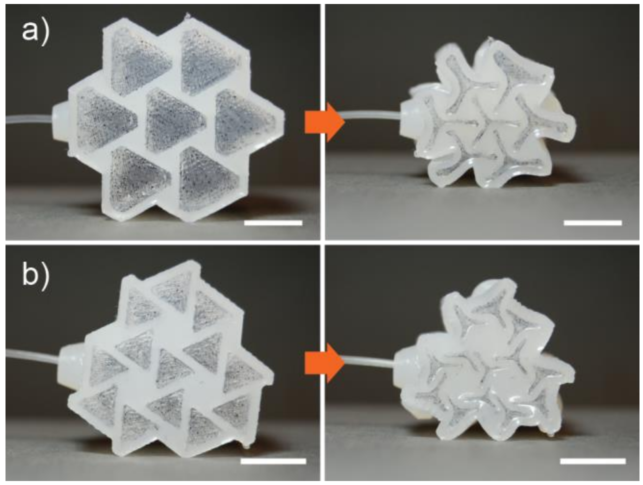

Figure S4. Parallel actuation in buckling actuator with different geometries. Scale bars are 1 cm.

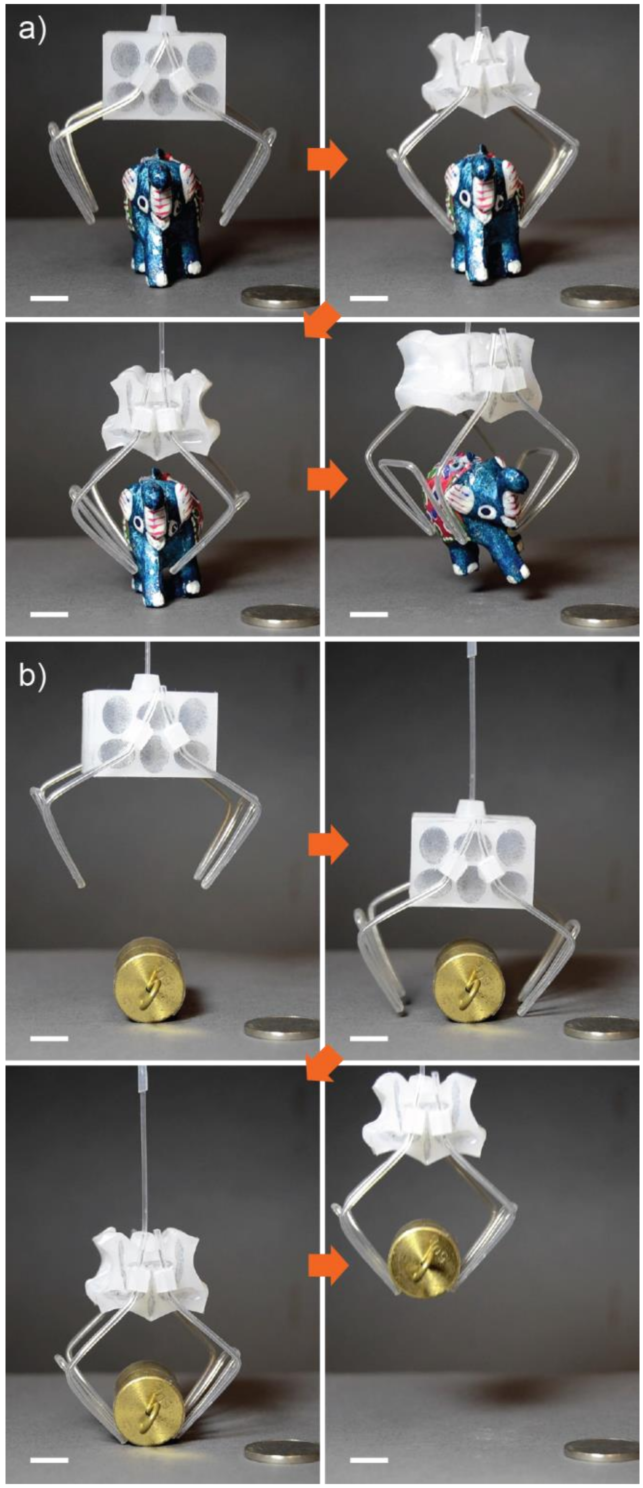

Figure S5. More examples of the buckling gripper. a) The buckling gripper picks up a toy elephant. b) The buckling gripper picks up a 50 g weight. Scale bars are 1 cm.

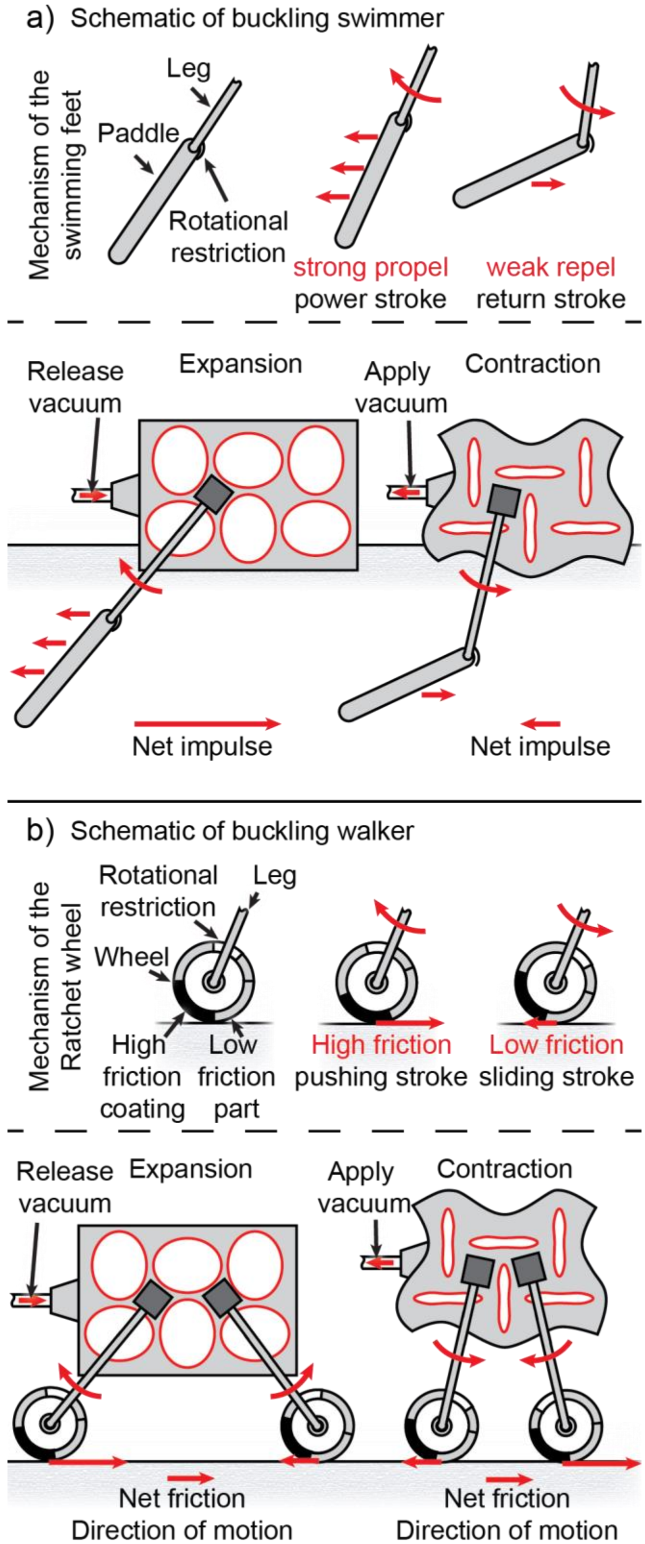

Figure S6. Detailed schematics of the buckling swimmer and the buckling walker.

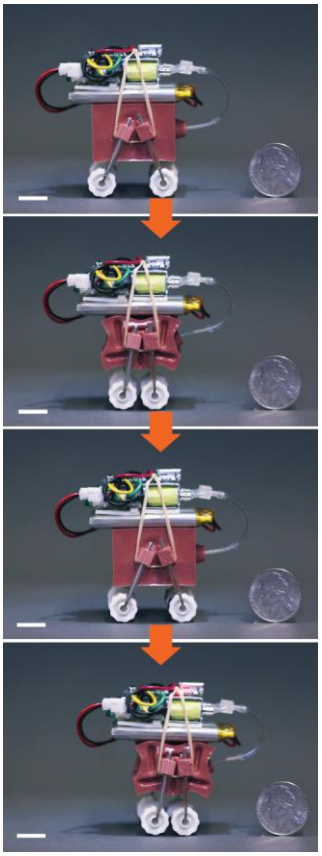

Figure S7. The soft robotic walker made untethered by carrying its own power supply, pump, valve, and circuit board. Scale bars are 1cm.

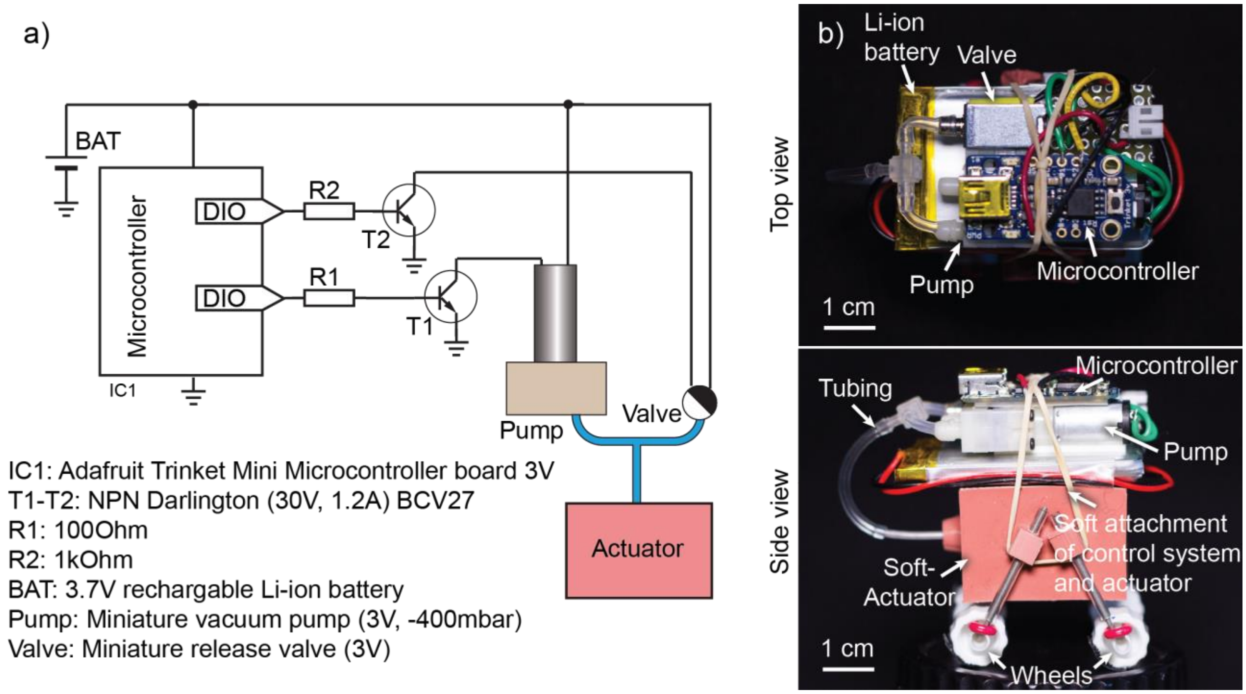

Figure S8. Circuit detail and schematics of the untethered soft robotic walker. Scale bars are 1 cm.

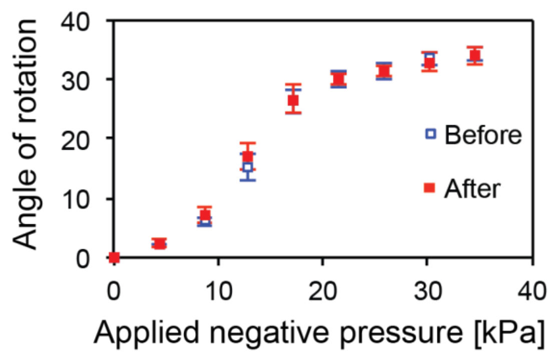

Figure S9 Comparison of the angle of rotation vs. applied negative pressure curve of three single-unit buckling actuator samples fabricated in Elastosil before and after 1000000 cycles of actuation at 2Hz.