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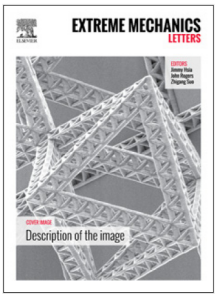

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3D Printed Unimorph Dielectric Elastomer Actuators

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Abstract:

Soft robotics is an emerging field enabled by the development of advanced soft materials, often with properties commensurate to their biological counterparts, with the purpose of reproducing locomotion and other distinctive capabilities of active biological organisms. The development of soft actuators is fundamental to the advancement of soft robots and bio-inspired machines. Among the different material systems incorporated in the fabrication of soft devices, ionic hydrogel-elastomer hybrids have recently attracted vast attention due to their favorable characteristics, including their analogy with human skin. Here, we demonstrate that this hybrid material system can be 3D printed as a soft dielectric elastomer actuator (DEA) with a unimorph configuration that is capable of generating high bending motion in response to an applied electrical stimulus. We characterized the device actuation performance via applied (i) ramp-up electrical input; (ii) cyclic electrical loading; and (iii) payload masses. A maximum vertical tip displacement of 9.78 ± 2.52 mm at 5.44 kV was achieved from the tested 3D printed DEAs. Furthermore, the nonlinear actuation behavior of the unimorph DEA was successfully modeled using analytical energetic formulation and a finite element method (FEM).

Keywords: Dielectric elastomer actuators, soft robotics, 3D printing, ionic hydrogels