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PROCEEDINGS

Hybrid Artificial Muscle: Enhanced Actuation and Load-Bearing Performance via an Origami Metamaterial Endoskeleton

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ABSTRACT

Owing to their compliance, soft robots demonstrate enhanced compatibility with humans and the environment compared with traditional rigid robots. However, ensuring the working effectiveness of artificial muscles that actuate soft robots in confined spaces or underloaded conditions remains a challenge. Drawing inspiration from avian pneumatic bones, we propose the incorporation of a light weight endoskeleton into artificial muscles to augment the mechanical integrity and tackle load-bearing environmental difficulties. We present a soft origami hybrid artificial muscle that features a hollow origami metamaterial interior with a rolled dielectric elastomer exterior. The programmable nonlinear origami metamaterial endoskeleton significantly improves the blocked force and load-bearing capability of the dielectric elastomer artificial muscle and an increased actuation strain. The origami hybrid artificial muscle demonstrates a maximum strain of 8.5% and a maximum actuating stress of 12.2 mN/mm^2 while preserving its actuating ability, even under a 450 mN load, which is equivalent to 155 times its own weight. We further investigate the dynamic responses and demonstrate the potential use of the hybrid artificial muscle in flapping-wing actuation applications.

KEYWORDS

Artificial muscle; origami metamaterial; dielectric elastomer; flapping wing

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