Silicone-based Artificial Muscle Fibers

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Silicone-based fibers are highly flexible and can respond to external stimuli and thereby mimic natural muscles. They can furthermore be combined into bundles of fibers and therefore resemble human muscles even further. In this work, we developed a continuous wet spinning method to prepare silicone fibers using a photocurable thiol-ene reaction between sulfhydryl (R-SH) and alkene (C=C) groups. The dimensions of the fibers are adjusted by modifying the flow rate of the silicone layer and internal removable solvent during the spinning process. The developed and optimized silicone fiber has an external diameter of 463 µm and uniform wall thickness of 78 µm. The silicone fiber exhibits enhanced tensile properties, with a 596 % strain at break and 0.64 MPa tensile strength, compared to these of the planar film (86% strain at break and 0.14 MPa tensile strength). The fiber actuator is then assembled by injecting ionic liquid as the core electrode and dip-coating ionogel as the electrical outer sheath. The fiber actuator exhibits a large linear strain of 9 % and repeatable and stable linear actuation strain over 1000 cyclic actuation tests. Furthermore, the fiber actuator can be assembled into bundles by winding a long fiber into a bunch for increased forces. Large actuation displacement is achieved by increasing the length of the fiber actuator as well. Inspired by a human arm, a weight-lifting system with Lego models demonstrates the high potential of the fiber actuator as artificial muscles. The work presented herein provides a pathway for creating active soft matter with complex architectures to enable fast programmable actuation for multiple applications including artificial muscle.

Keywords: artificial muscle, dielectric elastomer, fiber, linear actuator, ionic liquid, bundle

References

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