Silk Torsional Actuators: Automatic Moisture-Activated Emergency Locator for Aircraft Life Vests

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Silk, a natural protein fiber, has traditionally been used for textiles. It has high mechanical strengths, biocompatibility, and rich surface physicochemical properties, making it a promising candidate for fiber artificial muscles. Smart fiber actuators previously developed by the UTD Nanotech Institute are either based on expensive carbon nanotube and graphene fibers or polymer composites driven by a high-temperature-difference, which limits the applications of such fiber muscles. The low-cost and high-performance fiber torsional muscle based on commonly used natural silk fiber was driven by moisture. The neat silk fiber enabled a torsional stroke of 144 degrees/mm-1 with a maximum speed of 229 rpm. This was the first demonstration of the novel moisture-driven torsional silk actuator. By structural design, the twisted silk fibers could change their shape according to environmental moisture. To improve this torsional performance, biocompatible polyvinyl alcohol (PVA) was synthesized onto silk fibers by a simple dip-coating method. The silk/PVA composite fiber had a torsional stroke of 206 degrees/mm-1 and a maximum speed of 381 rpm during room temperature vapor absorption, which represented an increase of 43% and 66% from the neat silk fiber, respectively. In addition, PVA increased the tensile strength of silk fibers by 18%. The novel emergency locator designed for aircraft life vests used the twisted silk/PVA fiber as an automatic moisture-activated switch that turned on the built-in real-time GPS satellite tracking device. This allows anyone with the free iOS or Android mobile app to efficiently locate downed personnel crashed into the sea.

Awards Won:

Third Award of $1,000