Twisted Shape Memory Nanocomposite Fibers

Jinkai YUAN

Centre de Recherche Paul Pascal, CNRS, University of Bordeaux, Av. Schweitzer, 33600 Pessac, France

jinkai.yuan@crpp.cnrs.fr

Macroscopic rotating engines powered by electricity or fuel are common devices that are used to produce mechanical energies. However, it is difficult to integrate them into microdevices. Making high-speed and strong miniaturized engines with simplicity, robustness and low cost, remains particularly challenging. Up to now, the strongest rotary motors ever reported are based on the concept of twisted fibers. [1] The concept of twisted fiber can actually be used to develop rotary motors by involving several mechanisms, such as entropic elasticity of polymer chains, [2] solvent swelling in CNT yarns,[3], thermal expansion of polymers [1], or the expansion/contraction of graphene oxide (GO) via water adsorption and desorption.[4] Here, we study the shape memory effect by twisting polymer fibers and explore their application for strong microengines. [5]

For achieving high energy densityit is necessary to reinforce the torsional properties of polymer fibers by inclusion of nanoparticles. We prepared carbon nanotube (CNT)- or GO-doped polyvinyl alcohol (PVA) fibers by using a wet-spinning method. It is observed that CNT and GO nanosheets have nearly the same reinforcement efficiency on the tensile properties. However, GO nanosheets have more significant effect on the improvement of torsional properties because of its unique two-dimensional structure. We used such strong GO fibers to prepare torsional motors. By measuring the recovered angle against an applied constant torque, we achieved a maximum generated energy density as high as 2800 J/kg. To our knowledge, this is actually the first report of the use of graphene to reinforce torsional properties of polymer composites and the greatest energy density observed in rotary motors.

References

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