Shapeshifting Polymers: Reversible Transformations Useful for Microrobotics and Minimally-Invasive Surgery

Scientific Achievement

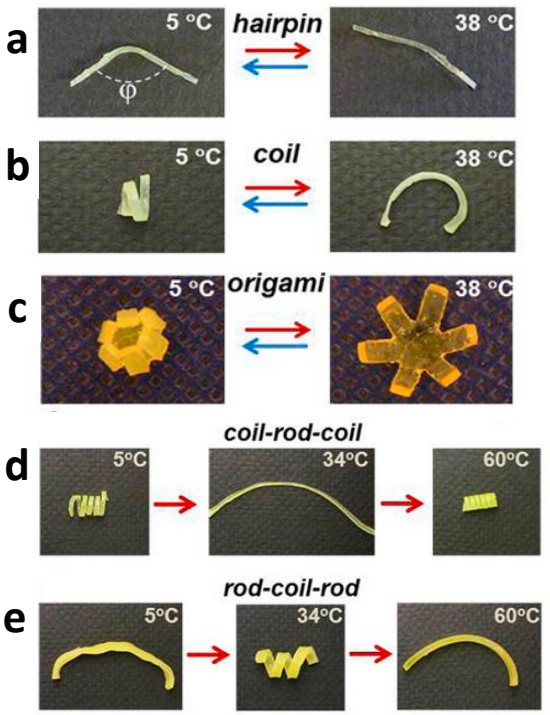
Devised a method for enabling semicrystalline elastomers to reversibly switch between encoded shapes – demonstrated with hairpin, coil, and origami gripper – without applying external force.

Significance and Impact

Shape memory materials are vital for minimally invasive surgery, hands-free packaging, micro-robotics, and are used in the aerospace industry. This method is unique in allowing reversible transformations without external force or contrived structural constraints, such as heterogeneous chemical compositions, making these polymers easier to manufacture.

Research Details

- Partial melting of an architectural scaffold of crystallites within the cross-linked polymer network leaves a template behind that reverts to the original shape when cooled.
- SAXS measurements at CFN and on beamline X9 at NSLS correlated changes in polymer crystallite orientation with shape changes.



Examples of two-way reversible shape memory (a-c) demonstrated by polymers. Three different shape transformations occur upon heating to 38°C and subsequent cooling to 5°C. One-way reversible shape transformations (d-e) were observed during heating from 5°C to 60°C. While the two-way transformations may be repeated multiple times, the one-way reversibility occurs only once.

J. Zhou, S. A. Turner, S. M. Brosnan, Q. Li, J. Y. Carrillo, D. Nykypanchuk, O. Gang, V. S. Ashby, A V. Dobrynin, and S. S. Sheiko. *Macromolecules*, 2014, 47, 1768-1776

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