

Thermadapt Shape Memory Polymer

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In contrast to thermoplastic shape memory polymers (SMP), thermoset SMP exhibit robust shape memory behaviours, but their permanent shape is not reconfigurable. In addition, the permanent shapes of both thermoplastic and thermoset SMP are defined by traditional molding process, which limits the geometric complexity of SMP based devices. Our recent work has established a third class of SMP (thermadapt SMP) with dynamic covalent crosslinkers that overcomes the above limitations. At relatively low temperatures, the covalent linkages remain dormant, the SMP exhibits the classical elasticity-based thermoset shape memory behaviours. At sufficiently high temperature such that the dynamic linkages are activated, the permanent shape can be reconfigured repeatedly via solid-state plasticity in a mold free manner. Additional spatio-temporal controls can further enrich the morphing behaviour. In particular, light-triggered crosslinking establishes spatio-selective molecular chain anisotropy, opening up a new opportunity for making single component soft robots. In addition, photo-thermal heating permits the introduction of digitally defined stress distribution in a free-standing flat film that can be used for information encoding via invisible mechanical colours.

References

1. Zou WK, Dong JT, Luo YW, Zhao Q, Xie T. "Dynamic Covalent Polymer Networks: from Old Chemistry to Modern Day Innovations", *Adv. Mater.* **2017**, 29, 1606100.
2. Zheng N, Fang ZZ, Zou WK, Zhao Q, Xie T. "Thermoset Shape-Memory Polyurethane with Intrinsic Plasticity Enabled by Transcarbamylation", *Angew. Chem. Int. Ed.* **2016**, 55, 11421.
3. Zhang GG, Zhao Q, Yang LP, Zou WK, Xi XY, Xie T. "Exploring Dynamic Equilibrium of Diels-Alder Reaction for Solid State Plasticity in Remoldable Shape Memory Polymer Network", *ACS Macro. Lett.* **2016**, 5, 805.
4. Zhao Q, Zou WK, Luo YW, Xie T. "Shape Memory Polymer Network with Thermally Distinct Elasticity and Plasticity", *Sci. Adv.* **2016**, e1501297.

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Author Biography:

Tao Xie is a professor in the College of Chemical & Biological Engineering at Zhejiang University. He obtained his BS and MS degrees in Polymer Chemistry from Zhejiang University in 1993 and 1996, respectively. From University of Massachusetts at Amherst, he received his Ph.D. in Polymer Science & Engineering in 2001 and was a recipient of the Omnova Solution award for his work there. He had since worked at the General Motors Global Research Lab (2001-2012) and HRL Laboratories (2012-2013) before his permanent move back to China in July 2013. His work on shape memory polymer has been published in *Nature*, *Adv. Mater.*, *Angew. Chem.*, and *Adv. Funct. Mater.*, and highlighted by various news media including *Nature*, *Science*, *MIT Tech Review*, *C&EN*, *MRS Materials360*, and *Chemistry world*. He is the inventor of over 70 patents and his recent awards include 2013 R&D 100 award, 2011 technologies that could change the way you manufacture, and 2011 Campbell award. He currently serves as the Associate Editor for *ACS Applied Materials & Interfaces*.

