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Editorial

Advanced Shape Memory Technology for Biomedical Engineering

Editorial

The ability to recover to the original shape only at the presence of the right stimulus is traditionally known as the shape memory effect (SME) [1]. The materials with such a capability are technically termed shape memory materials (SMMs) [2]. Typical SMMs include shape memory alloy (SMA) and shape memory polymer (SMP, including hydrogel), while typical stimuli are temperature (thermo-responsive, both heating or cooling), chemical (chemo-responsive, including water), light (photo-responsive) and magnetic (magneto-responsive) [3]. Although SMMs have been mostly used for actuators in the past, they have been proposed for new types of sensors as well, but not so successful till today [4-7].

Recent development in SMMs reveals a range of techniques not only to expand the potential applications of SMMs, but also to manipulate the shape recovery sequence in a more precise manner [8-10]. Hence, it is believed that the advanced shape memory technology is able to reshape product design in many ways, including in biomedical engineering [11-13].

Below are two examples

In Figure 1, polyethylene glycol (PEG) hydrogel is coated on a piece of poly (lactic-co-glycolic acid) (PLGA) wire. Both PEG and PLGA are Food and Drug Administration (FDA) approved materials for therapeutic devices owing to their excellent biodegradability and biocompatibility. The hybrid displays heating and water-responsive SME. After pre-stretching, it is able to buckle within less than one minute upon immersing in room temperature water due to water induced shape recovery in PEG. This concept of shape memory induced instability [10], has been proposed for temporarily blocking blood vessel for liver cancer treatment.

In Figure 2, a piece of surgical staple, which is made up of another widely used biodegradable polymer, namely polycaprolactone (PCL), has the self-tightening function upon heating to 48°C.

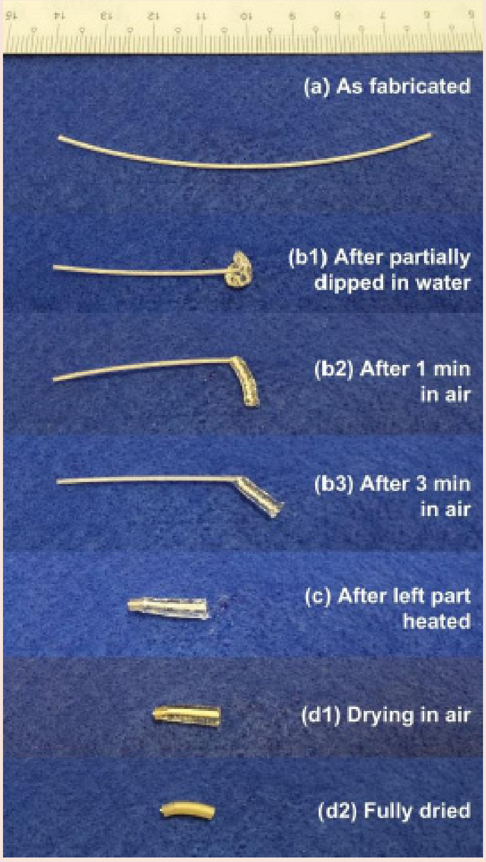

Figure 1: PEG/PLGA shape memory hybrid. (a-b): excellent shape memory induced buckling activated by room temperature water in right part. (b3-c): heating induced shape recovery in left part. (c-d2): full shape recovery upon drying in air.

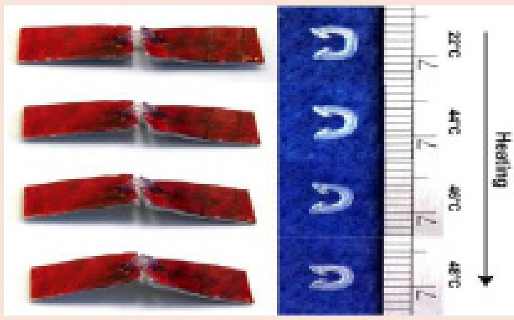

Figure 2: Biodegradable PCL surgical staple with self-tightening function. (Reproduced from [12] with permission).

References

1. Otsuka K, Wayman CM (1998) Shape memory materials. Cambridge: Cambridge University Press.
2. Huang WM, Ding Z, Wang CC, Wei J, Zhao Y, et al. (2010) Shape memory materials. Mater Today 13: 54-61.
3. Sun L, Huang WM, Ding Z, Zhao Y, Wang CC, et al. (2012) Stimulus-responsive shape memory materials: a review. Materials and Design 33: 577-640.
4. Funakubo H (1987) Shape Memory Alloys. New York: Gordon and Breach Science Publishers.
5. Huang WM, Yang B, Fu YQ (2011) Polyurethane shape memory polymers. New York, USA: CRC Press.
6. Duerig TW, Melton KN, Stockel D, Wayman CM (1990) Engineering aspects of shape memory alloys. Woburn, MA: Butterworth-Heinemann; 1990.
7. Shahinpoor M (2005) Shape memory alloy temperature sensor. Google Patents.
8. Tang C, Huang WM, Wang CC, Purnawali H (2012) The triple-shape memory effect in NiTi shape memory alloys. Smart Materials and Structures 21: 085022.
9. Wu X, Huang WM, Zhao Y, Ding Z, Tang C, et al. (2013) Mechanisms of the shape memory effect in polymeric materials. Polymers 5: 1169-1202.
10. Huang WM, Lu HB, Zhao Y, Ding Z, Wang CC, et al. (2014) Instability / collapse of polymeric materials and their structures in stimulus-induced shape / surface morphology switching. Materials and Design 59: 176-192.
11. Yang WG, Lu HB, Huang WM, Qi HJ, Wu XL, et al. (2014) Advanced shape memory technology to reshape product design, manufacturing and recycling. Polymers 6: 2287-308.
12. Huang WM, Song CL, Fu YQ, Wang CC, Zhao Y, et al. (2013) Shaping tissue with shape memory materials. Adv Drug Deliver Rev 65: 515-535.
13. Sun L, Huang WM (2010) Thermo/moisture responsive shape-memory polymer for possible surgery/operation inside living cells in future. Mater Des 31: 2684-2689.

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