Editorial corner – a personal view

Shape memory polymers and their future developments

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Since the shape memory (SM) effect was first utilized for the production of heat shrinkable polyethylene as far back as 1951, it took over 30 years to industrialize the same effect with block copolymers by Japanese companies. However, most works by then were based on their commercial products as documented in patents, and detailed structure-property relationships were sparse in open literatures. Since late 1990s, SM polymers (SMP) have drawn intensive scientific attentions as functional materials with ample potential applications.

SMP recovers its original shape from a large deformation when exposed to a stimulus which is mostly heat. Light, electric and magnetic fields may also be used to trigger shape change in suitable SMPs. However, these stimuli are generally used to generate heat. SM effect results from the combination of morphology and processing program.

Morphologically, SMP consists of fixed (hard) segments and reversible (soft) segment, or their aggregations (phases). Transition temperature of soft segment is switching temperature (T_s). So, block and segmented copolymers are major classes of SMP. Fixed phase contains physical or chemical cross-links which are thermally stable above T_s . It is typically dispersed in reversible phase and is triggered by external stimuli. Morphology of soft segment and intercross-link distance determine the recoiling above T_s .

SMP has rooms for performance improvement in strain fixity, recovery, and durability. Moreover,

reversibility rather than the one way operation, and high recoiling force would open up a new era of SMP. Switching by light, pH, pressure, sound, moisture, etc will make the materials more versatile. Multifunctionalization like the coupling of SM effect with biocompatibility and biodegradability will find biomedical device applications.

Skilled molecular design for specific environment is of prime importance. Hybridization with other polymers and inorganic fillers in nano-order are other choices. Multiple SM behavior where strain is recovered in multiple steps could be designed from multiphase polymers. Simple addition of fillers often gives partial success as to SM effect. However, when fillers are chemically bonded onto the polymer chains, excellent SM performances can be achieved. SMP is a rapidly moving area and a lot more are expected to come in the near future.

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