

Enhanced Shape Memory Properties of Polystyrene-Polybutadiene Block Copolymers

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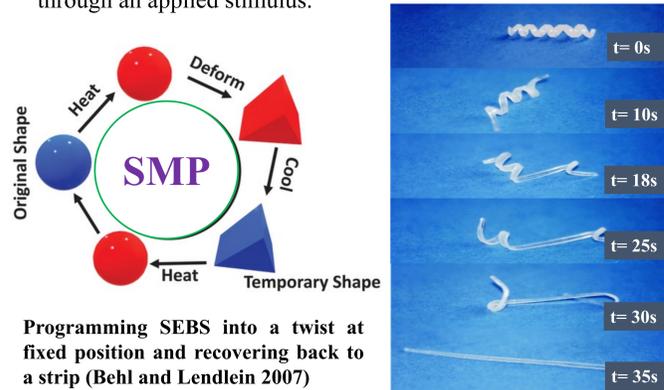


OBJECTIVE

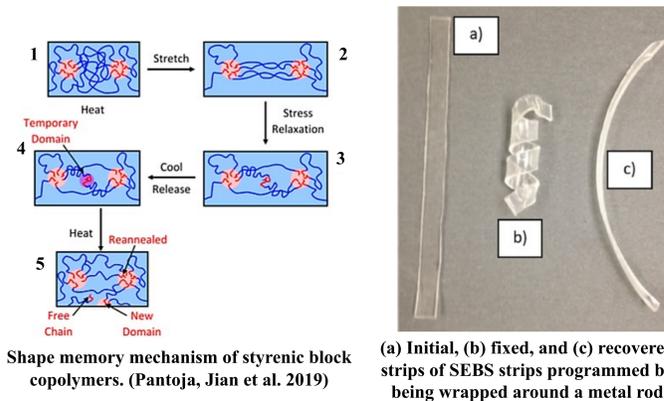
To investigate how thermal annealing induced crosslinking in SBS triblock copolymer enhances double network formation, improving shape memory performance through optimized shape fixity, recovery and high strain application.

INTRODUCTION

➤ **Shape-memory polymers (SMPs)** are cross-linked polymer networks containing permanent and temporary network allowing fixation of a temporary shape and recovery of an initial shape through an applied stimulus.



➤ **Mechanism:** In SBS, an ABA triblock thermoplastic elastomer, shape fixing occurs by annealing a deformed sample below T_g to allow temporary domains to form. Recovery occurs by heating the sample softening the temporary domains first.



➤ **Calculations:**

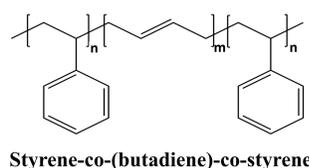
$$\text{Fixity \%} = \left(\frac{\epsilon_f - \epsilon_i}{\epsilon_p - \epsilon_i} \right) \times 100$$

$$\text{Recovery \%} = \left(\frac{\epsilon_p - \epsilon_r}{\epsilon_p - \epsilon_i} \right) \times 100$$

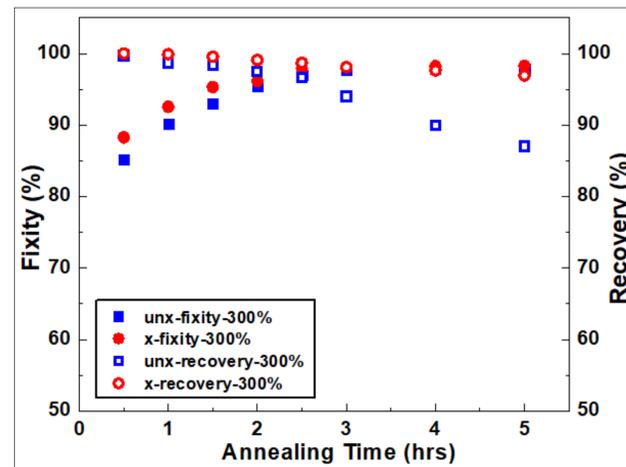
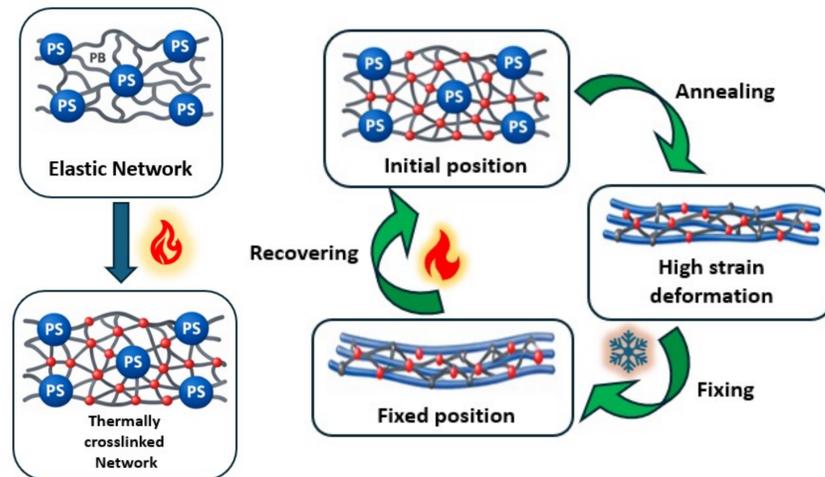
ϵ_i = Initial strain
 ϵ_f = Fixed strain
 ϵ_p = Programmed strain
 ϵ_r = Recovered strain

MATERIALS USED

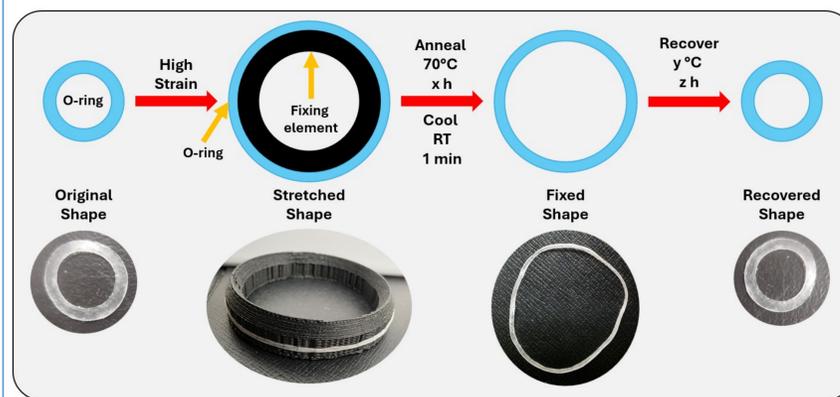
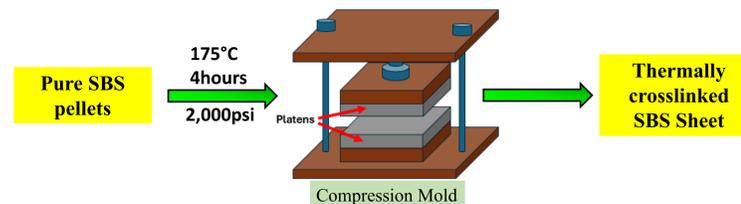
❖ The major material used for this experiment is **Calprene 501** (Dynasol Group) which is a SBS triblock copolymer.



HYPOTHESIS

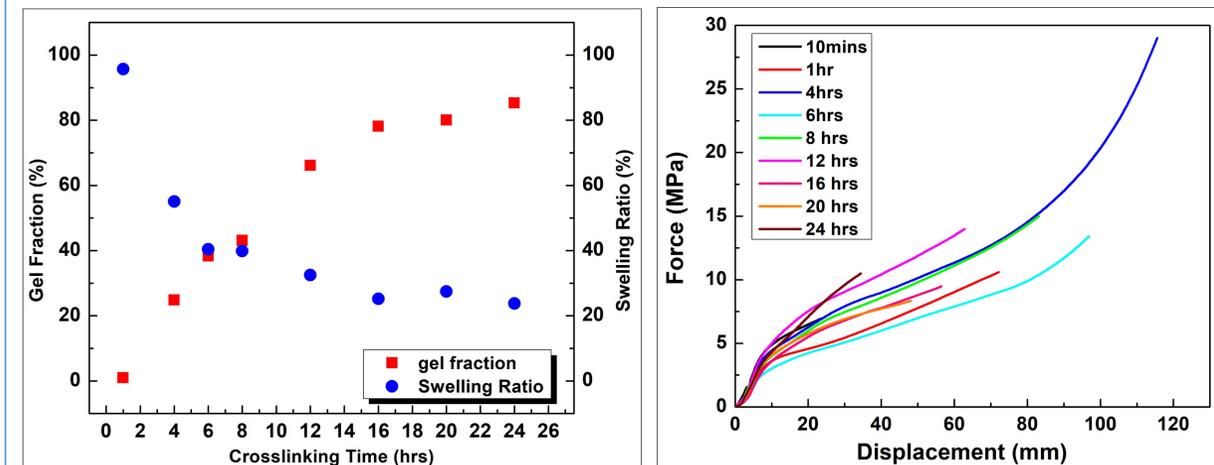


SHAPE MEMORY POLYMER FORMATION



RESULTS AND DISCUSSIONS

GEL FRACTION and F-D CURVE

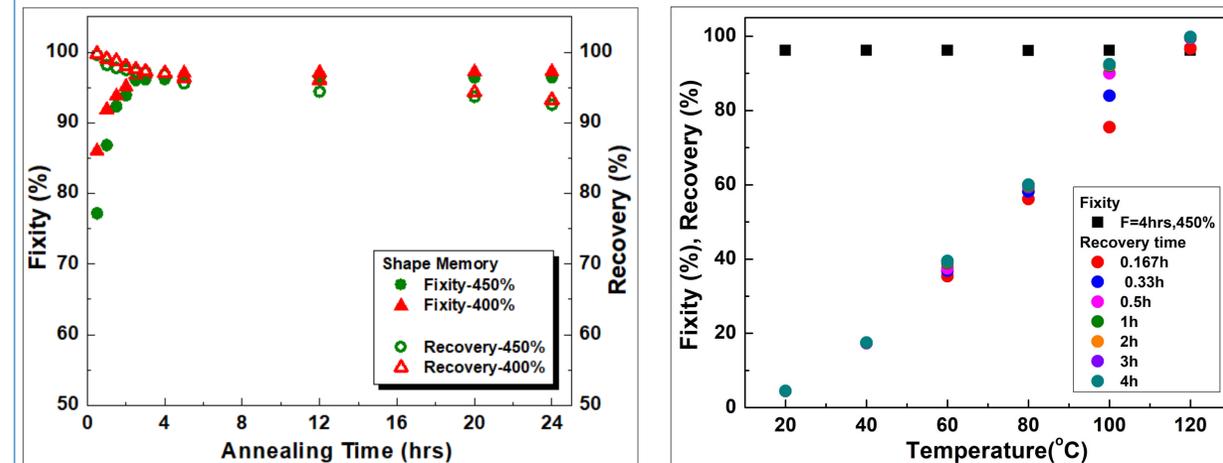


$$\text{Gel fraction } (G) (\%) = \left(\frac{W_d}{W_i} \right) \times 100$$

$$\text{Swelling Ratio } (\%) = \left(\frac{W_s - W_i}{W_i} \right) \times 100$$

W_i = Initial weight; W_d = Dried weight; W_s = Swollen weight

SHAPE MEMORY ACTUATION



CONCLUSION & FUTURE WORK

- ❑ Higher crosslink time increases stiffness due to higher crosslink density.
- ❑ Optimal crosslinking improves the strain at break immensely, enhancing higher strain actuation.
- ❑ Fixity % and Recovery % increases with increasing annealing and recovery time respectively.
- ❑ Fixing below T_g and Recovering above T_g of styrene gives the fastest and best comparable actuation properties.
- ❑ This lays foundation to understanding microstructure and mechanical behavior dependent on the orientation.

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