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Supplementary Information

Composite Material with Room Temperature Shape Processability and Optical Repair

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1. Effect of Melting Temperature of Paraffin Wax

Three paraffin waxes of different melting temperatures were used to prepare the shape memory SEBS/PW composite material. The results in Figure S1 show that they lead to similar fixity ratios R_f upon different elongations at room temperature.

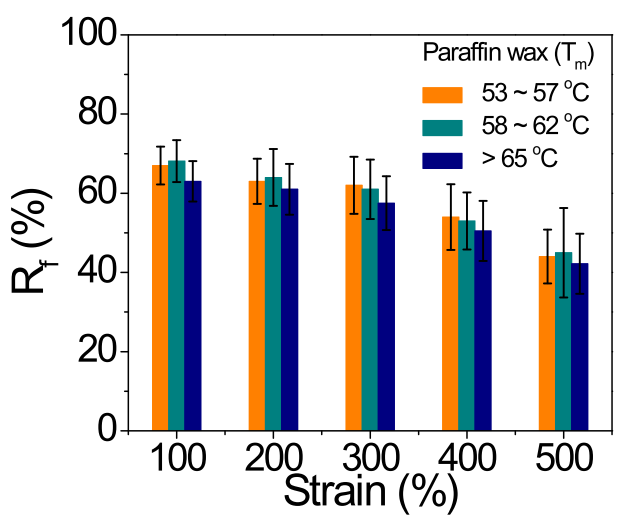

Figure S1. Effect of melting point of paraffin wax on the shape fixity ratio of the composite material.

2. Repeated Cycles of Room Temperature Deformation and Shape Recovery

Figure S2 shows the effect of repeated elongations on R_f. Interestingly, the results show that repeating the deformation can result in higher R_f. In each deformation step the polymer was stretched to a certain strain and subsequently released from the external stress to obtain a elongated temporary shape, afterwards the polymer was stretched to the same strain as in the last elongation step and then released from the stress to obtain a new temporary shape. By repeating this cycle the achieved R_f increased from 48.2%, 60.7% and 68.3% to 64.7%, 78.2% and 83.1% after repeating the cyccle 5 times with an elongation 100%, 300% and 500%, respectively. This provides an easy way to gain a temporary shape with higher R_f.

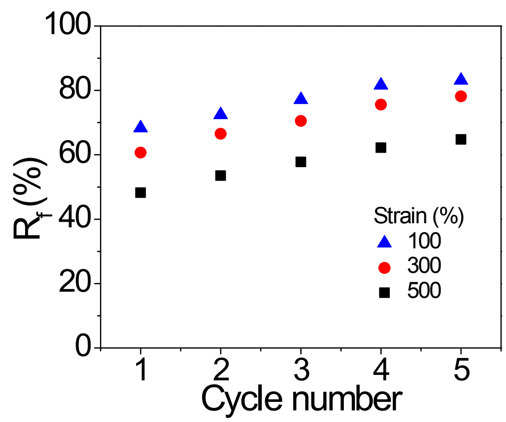

Figure S2. Effect of repeated elongation/relaxation cycles on the shape fixity ratio of the composite material.

3. DSC Measurements of SEBS/PW of Various Compositions

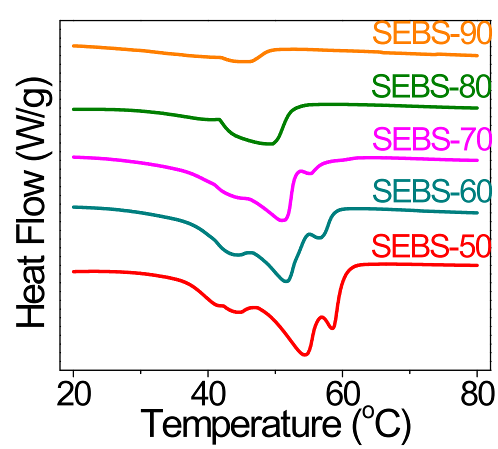

Figure S3. DSC heating curves of SEBS/PW of various compositions showing reduced endothermic melting peaks of paraffin wax at lower content.

4. Effect of AuNPs

The room temperature programmability of temporary shape of the hybrid SEBS/PW/AuNP material was investigated. The results in Figures S4 and S5 show that the effect of added AuNPs has little effect on the shape memory properties of the composite material. The obtained R_f of SEBS-50/AuNP in Figure S4 is very similar to that of SEBS-50, and the shape recovery curves of SEBS-50/AuNP in Figure S5 are basically the same as those of SEBS-50.

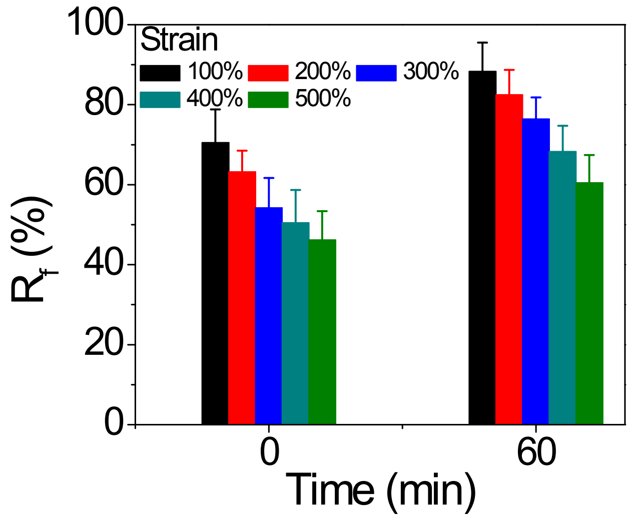

Figure S4. Effect of strain on the fixity ratio R_f of SEBS/PW/GNP composite materials.

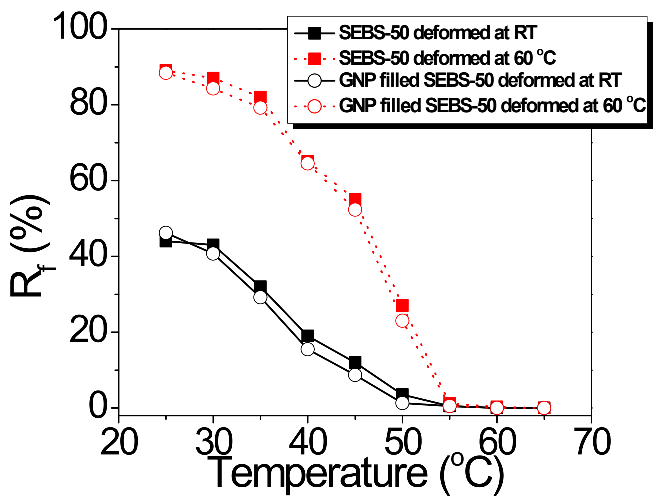

Figure S5. Shape recovery behaviors of SEBS-50 and SEBS-50/AuNP deformed at room temperature and 60 °C.

5. Fracture Healing Behavior

The possibility of fracture healing of the SEBS/PW composite material was also investigated, and the results are shown in Figure S6. After a film was cut in the center, the fracture was visible on polarized optical microscope (POM) (photo a). Under heating to 80 °C, the distance between the fracture surfaces was rapidly reduced (photos b and c after 1 min and 5 min, respectively). Tensile test results show that after heating the material to 80 °C for a short time (1-5 min), the Young's modulus was recovered (the similar slope of stress-strain curves over the small strains). However, the film broke at much smaller elongations than the original sample, and the rupture took place at the initial fracture interface. This result suggests that the recovery f the Young's modulus came from healing of paraffin crystals that melt at 80 ° d recrystallize on cooling. By contrast, the absence of a healing mechanism r the rubbery polymer chains explains the absence of healing for the elongation.

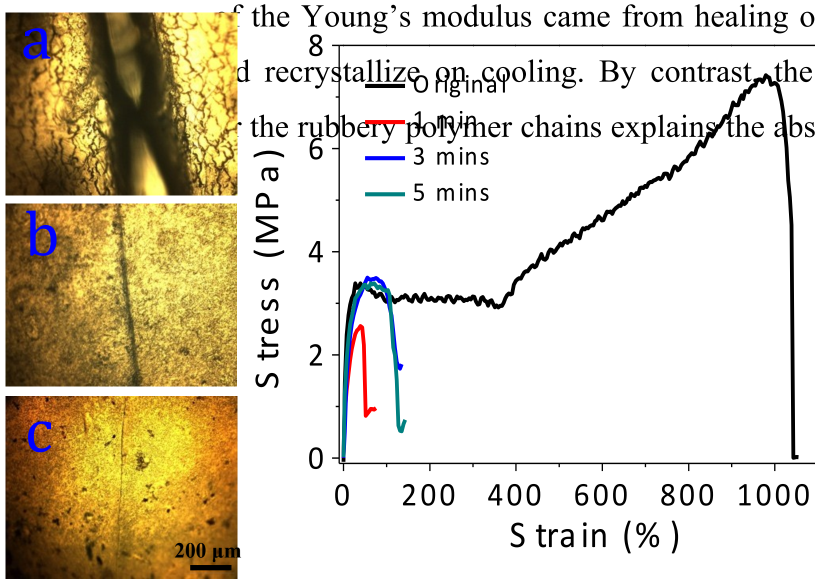

Figure S6. Left: optical microscope images of the cut inflicted on a film of SEBS-50 (a), after heating to 80 °C for 1 min (b) and 5 min (c). Right: room temperature stress-strain curves of SEBS-50 before cutting (original) and after cutting and heating to 80^{o}C for 1-5 min followed by cooling.