Electronic Supplementary Information

Mechanically robust and shape-memory hybrid aerogels for super-insulation applications

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1. FTIR measurements

To detect the chemical reactions, Fourier transform infrared spectroscopy (FTIR) spectra were collected on a Perkin Elmer FTIR spectrometer fitted with an attentuated total reflectance cell. The FTIR spectra of GO, GO aerogel, SEBS and GO/SEBS-2 are shown in Fig. S1.

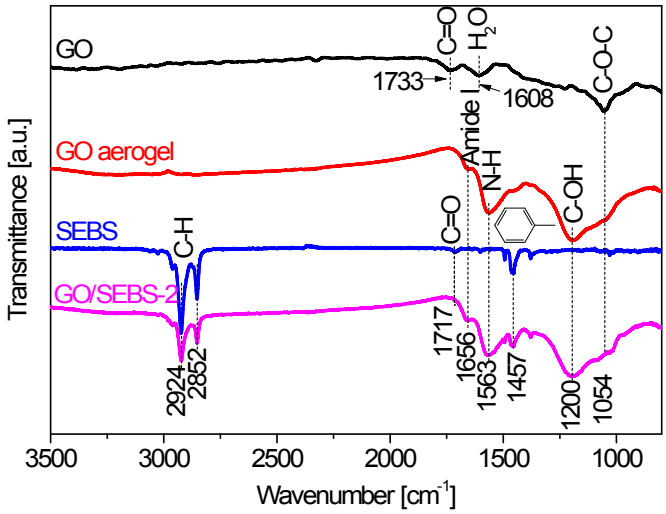

Fig. S1. FTIR spectra of GO, GO aerogel, SEBS and GO/SEBS-2.

2. SAXS measurements

To determine the phase morphology of pure SEBS and SEBS in the hybrid aerogels, small angel X-ray scattering (SAXS) measurements were performed on XEUSS 2.0 with a wavelength of 0.154nm under vacuum. Two-dimensional SAXS patterns were acquired using a Pilatus SAXS detector. The exposure time was 300s. A silver behenate ($AgC_{22}H_{43}O_2$) standard was used to calibrate the scattering angle. The sample-to-detector distance was 2479 mm. All diffraction and scattering signals were corrected for beam fluctuation and background scattering. X-ray data analysis was performed using the Fit2D software to acquire

SAXS intensity vs. scattering vector curves, as shown in Fig. S2

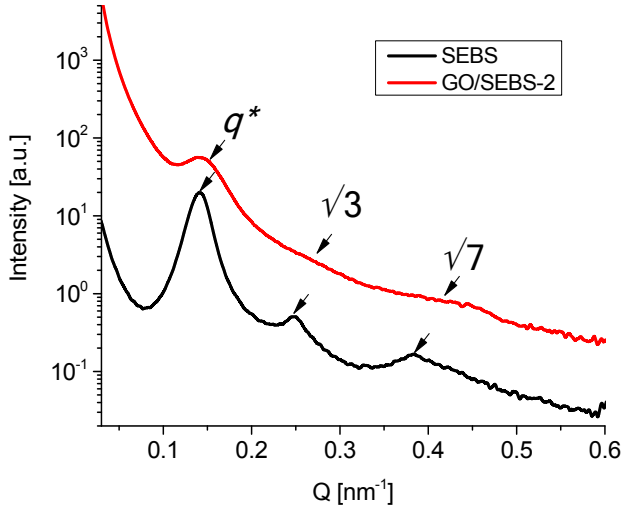

Fig. S2. SAXS intensity as a function of scattering vector (Q) based on 360° azimuthally integration of 2D images.

3. DSC measurements

To determine the glass transition temperature (T_g) of SEBS, differential scanning calorimetry (DSC) was performed using Q200 (TA Instruments). The mass of the samples was about 8 mg. To clear the thermal history, the samples were first heated from room temperature to 150 °C and then cooled to 40 °C at a rate of 20 °C/min. Afterwards the heat flow of the samples was recorded at a heating rate of 20 °C/min, as shown in Fig. S3. The T_g value was determined as the temperature at the inflexion point of the heat flow curve. The T_g values of SEBS and GO/SEBS-2 elastomers are 87.1 °C and 87.7 °C, respectively.

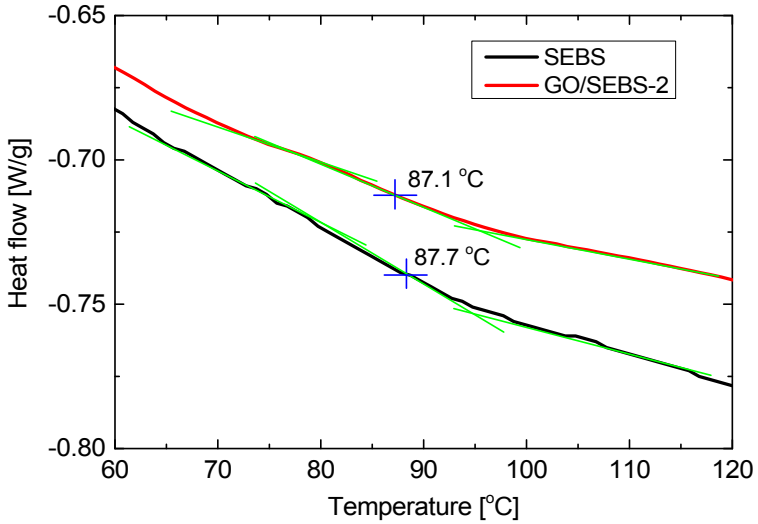

Fig. S3. DSC heat flow curves of SEBS and GO/SEBS-2

4. BET measurements

The Brunauer–Emmett–Teller specific surface area (BET) was determined by nitrogen physisorption using a Micromeritics ASAP 2020 HD88 automated system. 0.1–0.2 g of the aerogels was first degassed at 100 °C for 12 h prior to nitrogen adsorption at -196 °C. BET analysis was carried out for a relative vapor pressure of 0.01–0.3 at -196 °C. The BET surface areas for the GO and GO/SEBS aerogels are shown in Fig. S4. The average pore size of the NFC aerogels was estimated from the nitrogen desorption isotherm by a Barrett–Joyner–Halendar method.

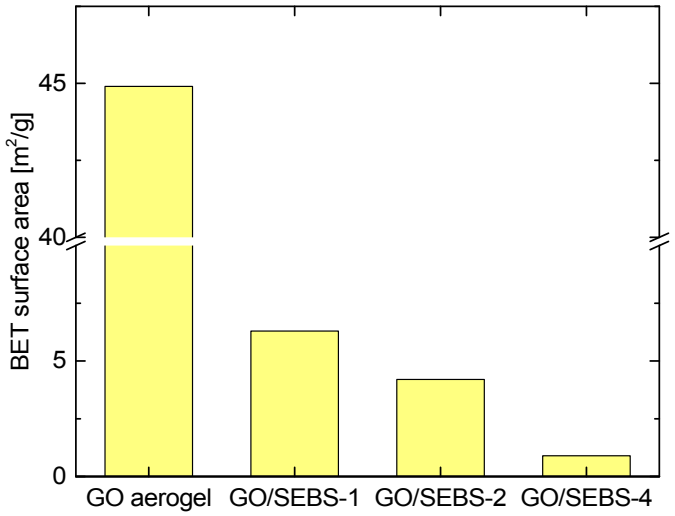

Fig. S4. BET surface area

5. Compression tests

Uniaxial cyclic compression measurements were performed on an Instron 3342 with a 100 N load cell. The measurements were conducted at room temperature in air using a crosshead velocity of 2 mm/min to different maximum strains, including 25%, 50% and 80%. The efficiency of energy dissipation during each compression cycle is defined as A_H/A_L, where A_H and A_L are the integrated area of the hysteresis loop and that under the loading curve respectively, as shown in Fig. S5. The photographs of a compressed sample to maximum strains of 50% and 80% are shown in Fig. S6.

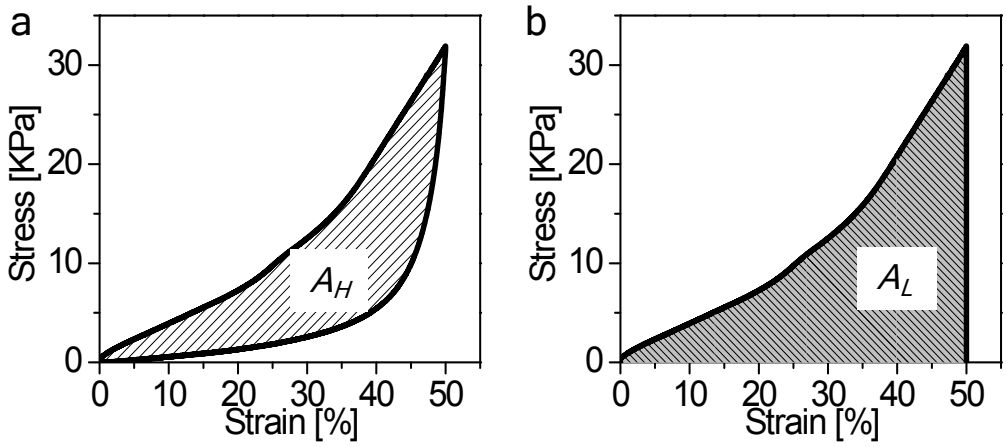

Fig. S6. Calculation of energy dissipation efficiency in terms of A_H/A_L, where A_H and A_L are the integrated area of the hysteresis loop (a) and that under the loading curve (b), respectively.

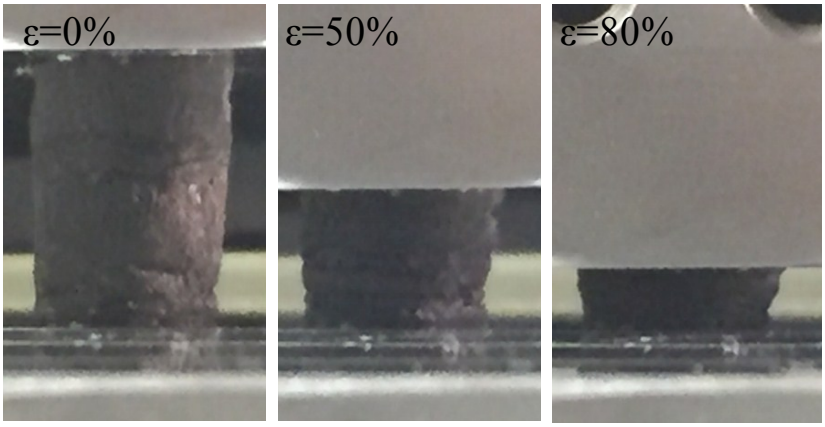

Fig. S6. Compression of the hybrid aerogel to different strains.