Supporting information for:

Simultaneously Strengthening and Toughening Soy Protein Isolate-based Films Using Poly(Ethylene Glycol)-block-Polystyrene (PEG-b-PS) Nanoparticles

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1. Characterization

^{1}H NMR (Bruker Avance III 400 MHz) analysis was performed to character the synthesized block copolymers with $CDCl_3$ as the solvent. The molecular weight and the polydispersity index (PDI, PDI = M_w/M_n) were determined by gel permeation chromatography (GPC) equipped with three SHODEX columns and an RL 2000 refractive index detector; DMF containing LiBr (0.012 mol·L^{-1}) was used as eluent with a flow rate at 1.0 mL·min^{-1}, and the narrowly polydispersed polystyrene as calibration standard.

2. Figure S1

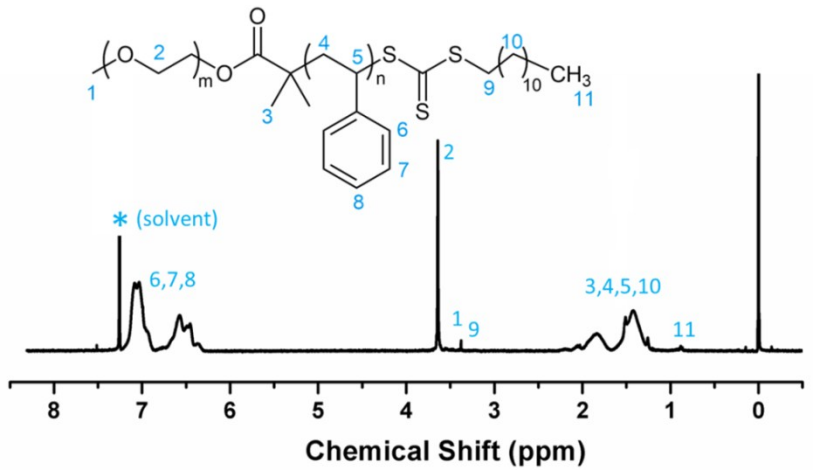

Fig. S1 The ^{1}H NMR spectrum of the PEG_{45}-*b*-PS_{276} nanoparticles.

3. Figure S2

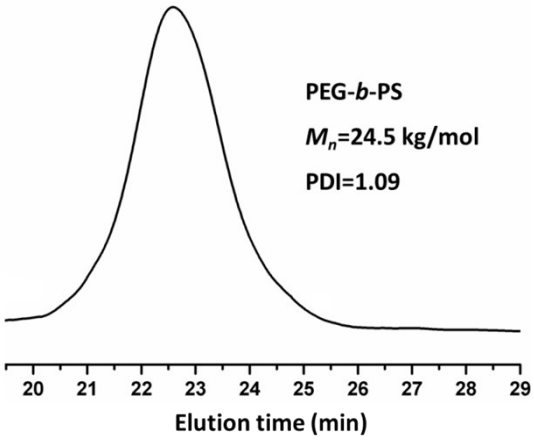

Fig. S2 The GPC trace of the PEG_{45}-*b*-PS_{276} nanoparticles.

4. Figure S3

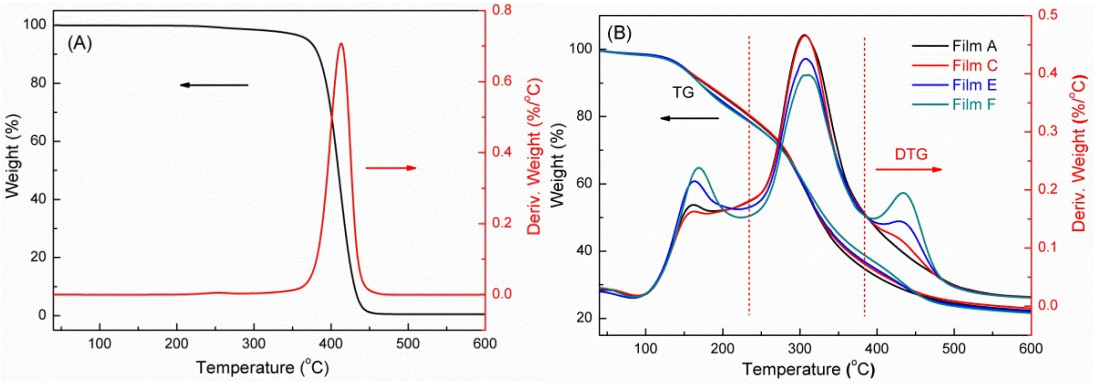

Fig. S3 TG and DTG curves of (A) PEG_{45}-*b*-PS_{276} diblock copolymer and (B) SPI/PEG_{45}-*b*-PS_{276} nanocomposite films (Films A, C, E, and F).

5. Table S1

Table S1 Thermo-degradation data of PEG_{45}-*b*-PS_{276} diblock copolymer and SPI/PEG_{45}-*b*-PS_{276} nanocomposite films

Entry	T_{max1}[a] (°C)	M_{L1}[b] (%)	T_{max2} (°C)	M_{L2} (%)	T_{max3} (°C)	M_{L3} (%)
ES (PEG-*b*-PS)	-		-		413.02	99.47
A	153.36	11.99	305.95	63.18	-	-
B	164.46	11.80	308.30	52.49	438.16	10.23
C	162.91	11.76	306.74	52.67	433.10	10.76
D	165.89	11.39	306.06	52.27	440.08	11.62
E	163.19	12.04	307.52	52.06	428.05	12.39
F	168.85	12.59	310.86	49.23	434.05	14.89

[a] Temperature of maximum degradation rate.
[b] Weight loss percentage during the degradation stage.

Thermal performance of SPI/PEG_{45}-*b*-PS_{276} nanocomposite films

The thermal properties of SPI/PEG_{45}-*b*-PS_{276} nanocomposite films were examined by TGA at a temperature range from 40 °C to 600 °C. The weight loss traces, derivative TG (DTG) curves, and thermo-degradation data are shown in Fig. S3 and Table S1, respectively. The main decomposition stage of the PEG_{45}-*b*-PS_{276} diblock copolymer was observed at 413.02 °C (Fig. S3A). The SPI-based films showed two main degradation stages exclusive of the dehydration reaction at 40 °C to 120 °C (Fig. S3B): First, glycerol degradation from 120 °C to 250 °C; and the second degradation at 250 °C to 400 °C of the protein backbone breakages. Apparently, the degradation peaks around 413 °C of PEG_{45}-*b*-PS_{276} diblock copolymer were well-retained in the SPI/PEG_{45}-*b*-PS_{276} nanocomposite films and ranked as the third degradation stage, where peak temperatures at maximum degradation rate (T_{max3}) shifted backward from 413.02 °C to 433.10 °C (Film C), likely reflecting the enhanced thermal stability of the nanocomposite films which was primarily resulted from hydrogen bonding between the diblock polymer and SPI matrix. As the PEG_{45}-*b*-PS_{276} nanoparticles addition increased, weight loss of the protein backbone (M_{L2}) dropped from 63.18% (control) to 49.23% (Film F), indicating the benign combination of the nanoparticles and SPI matrix. In addition, the T_{max2} values in the second stage of protein backbone degradation increased from 305.95 °C (Film A) to 310.86 °C (Film F), likely related to hydrogen bonding interaction between PEG_{45}-*b*-PS_{276} and SPI matrices which increased the thermal stability of the resultant films, confirmed by the ATR-FTIR results.