Supplementary Information

A meniscus-inspired, environmentally robust, tough soybean-based composite adhesive

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This supporting information includes:

Preparation of TGA

Triglyceride amine (TGA) was synthesized in the laboratory following the preparation method described in previous literature. The preparation process is illustrated in Fig. S1. Epichlorohydrin was mixed with an ammonia solution at a molar ratio of 5:1 and stirred continuously at room temperature for 24 h to ensure the reaction proceeded thoroughly. Subsequently, the mixture was heated at 60 °C for 2 h to further promote the completion of the reaction, followed by cooling to 20 °C. During this process, an excess of 50 wt% sodium hydroxide solution was added to the mixture, and stirring was continued for 2 hours to neutralize acidic by-products and facilitate the complete conversion of epichlorohydrin. Finally, residual epichlorohydrin and ammonium hydroxide were removed by vacuum distillation, yielding a pale-yellow viscous liquid, which was the desired cross-linking agent.

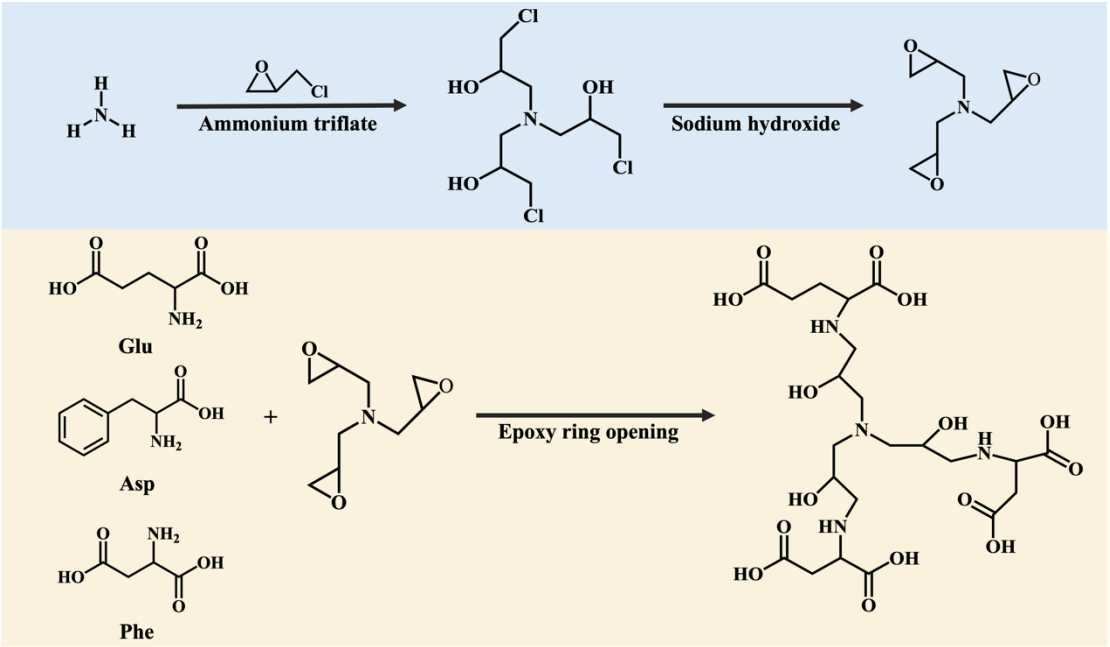

Fig. S1 Preparation process of TGA and its reaction mechanism with amino acids.

Preparation of EIA.

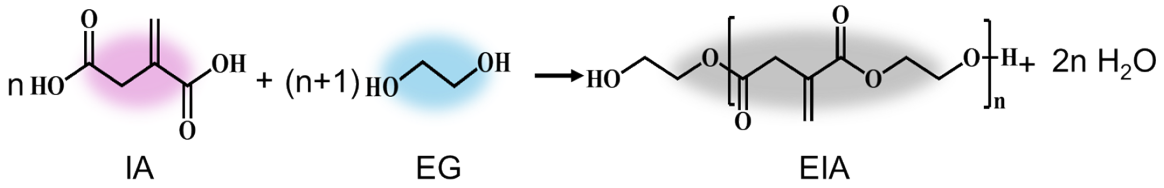

Fig. S2 Preparation process of EIA.

Synthesis of SM-based Adhesives

SM-based adhesives were prepared using a one-pot polymerization process involving SM, TGA, and EIA. To obtain a homogeneous SM/EIA adhesive, SM and TGA were dissolved in deionized water and thoroughly stirred at 25 °C for 5 min. EIA was added sequentially at 5 wt%, 10 wt% and 15 wt%, followed by stirring for another 5 min, and the mixture was then allowed to stand at 25 °C for 1 h (specific formulations are listed in Table S1). Through this simple process, a series of SM/EIA adhesives were fabricated.

Table S1 Components of the SM-based adhesives.

Number	Sample	SM(g)	Water (g)	TGA(g)	EIA(g)
0	PSM	30	70	0	0
1	SM	30	70	2	0
2	SM-10EIA	30	70	2	11.3
3	SM-15EIA	30	70	2	18.0
4	SM-20EIA	30	70	2	25.5

Performance Comparison with Other Adhesives

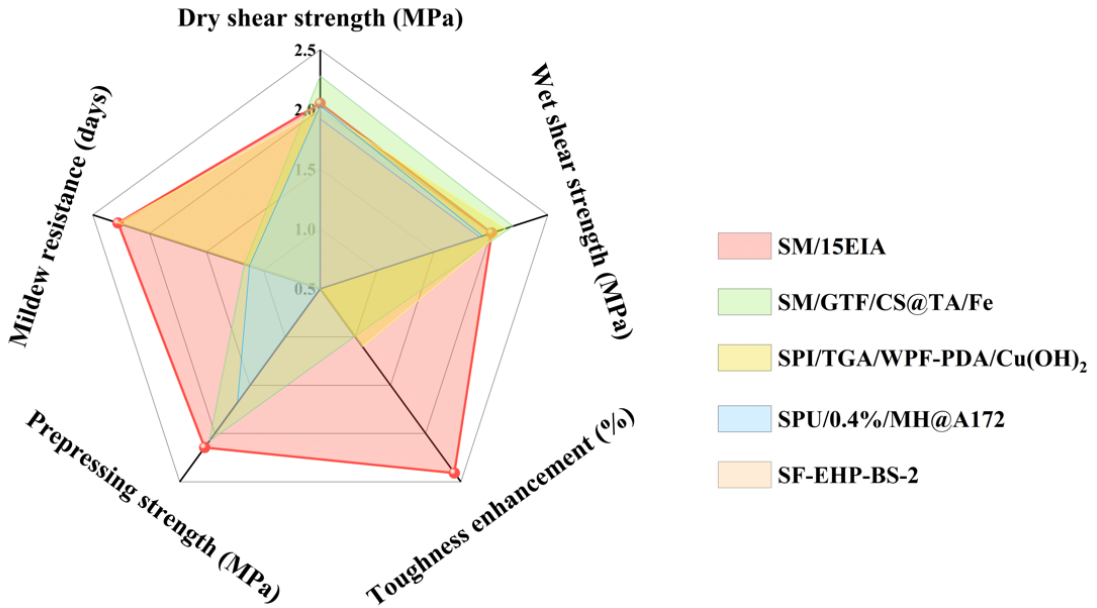

Fig. S3 Performance comparison with other adhesives.

Ball impact test

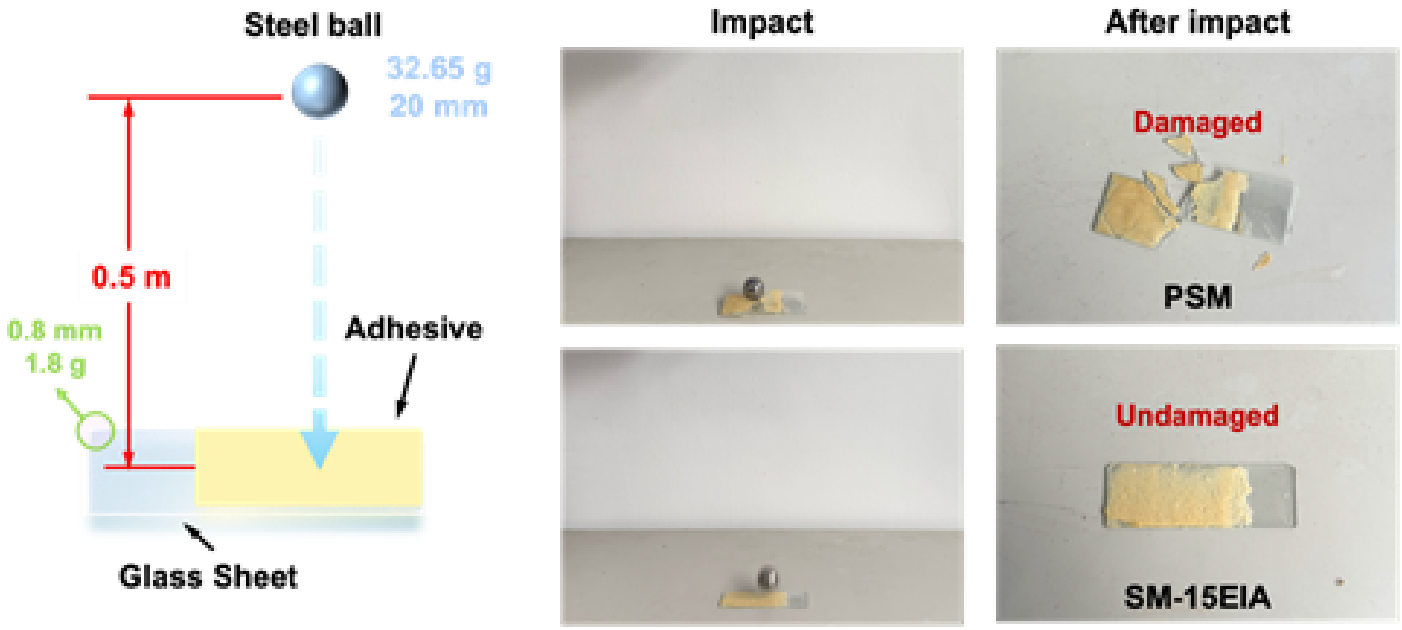

Fig. S4 Ball impact test of SM-based adhesives.

Life cycle assessment comparison.

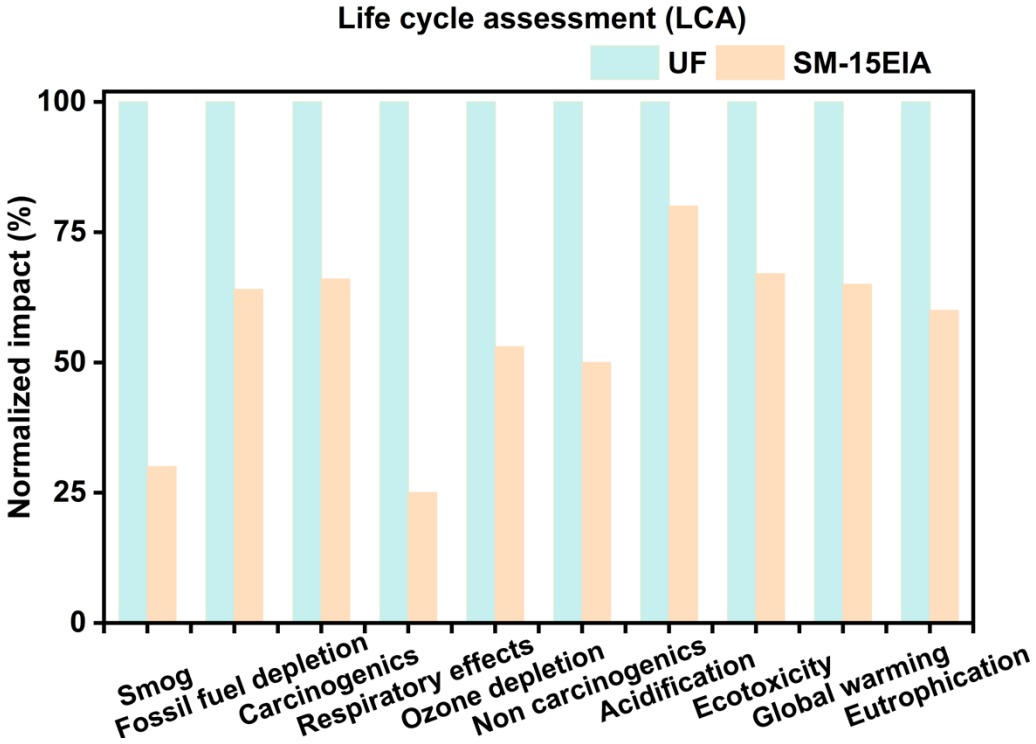

Fig. S5 Life cycle assessment comparison of SM-15EIA and UF.