Supporting Information

Fabrication of strong, tough, recyclable, and multifunctional bio-based epoxy vitrimer via constructing polyarylation-enhanced dynamic networks

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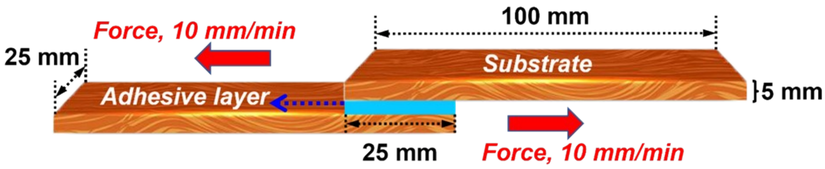

Fig. S1. Dimensions of the specimen for adhesion performance, bonding performance, and water resistance measurements.

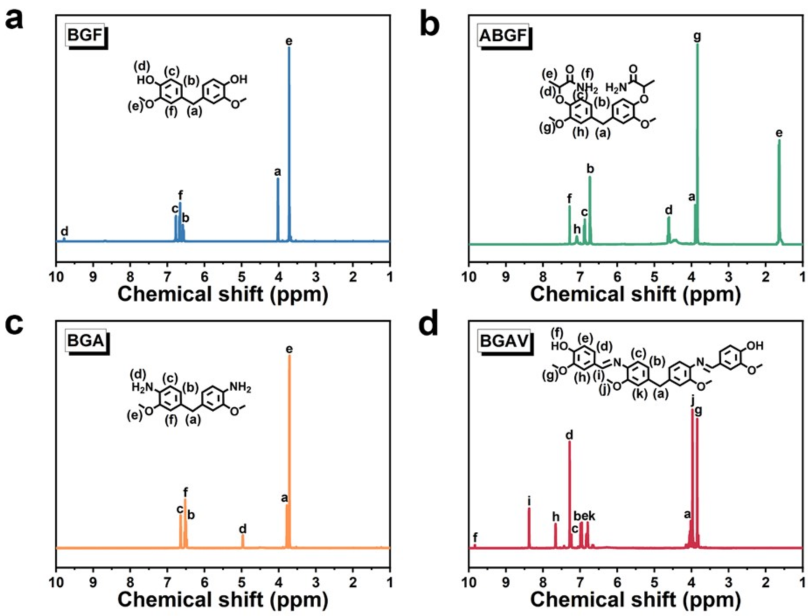

Fig. S2. [1]H nuclear magnetic resonance (NMR) spectra of (a) BGF, (b) ABGF, (c) BGA, (d) BGAV.

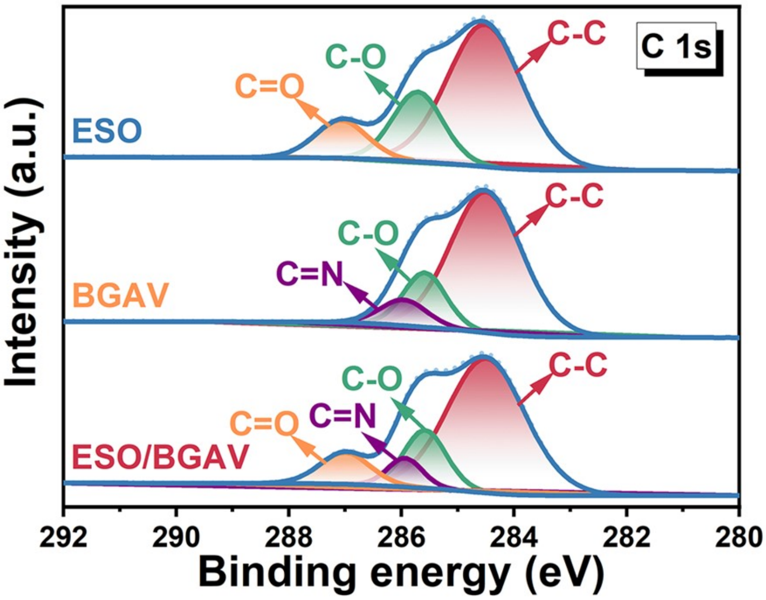

Fig. S3. X-ray photoelectron spectroscopy (XPS) spectra of ESO, BGAV, and ESO/BGAV.

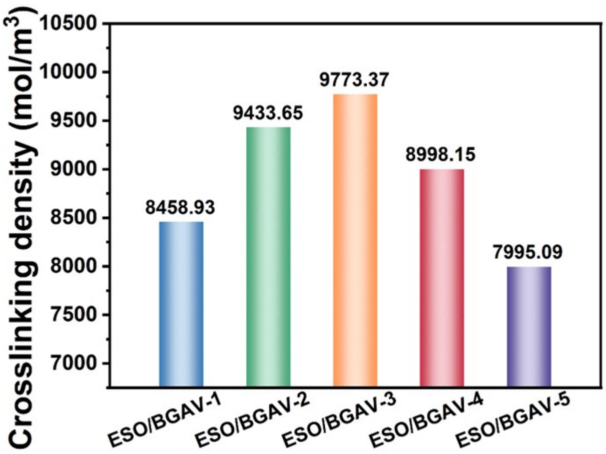

Fig. S4. The crosslinking density of different ESO/BGAV epoxy vitrimers.

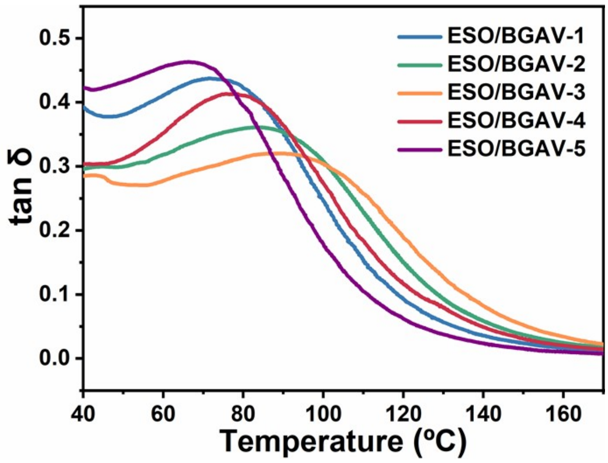

Fig. S5. Loss tangent (tan δ) of different ESO/BGAV epoxy vitrimers.

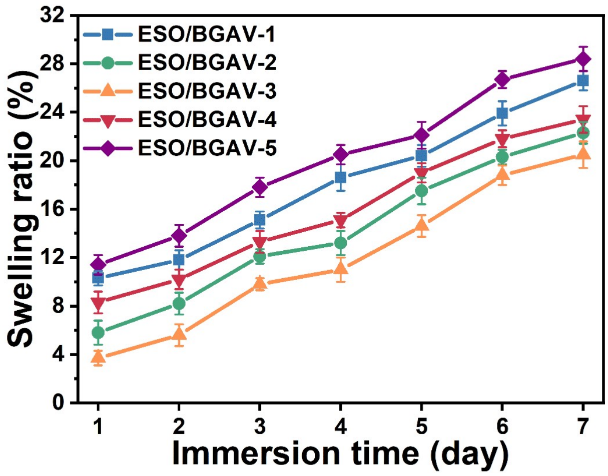

Fig. S6. Swelling ratio of different ESO/BGAV epoxy vitrimers.

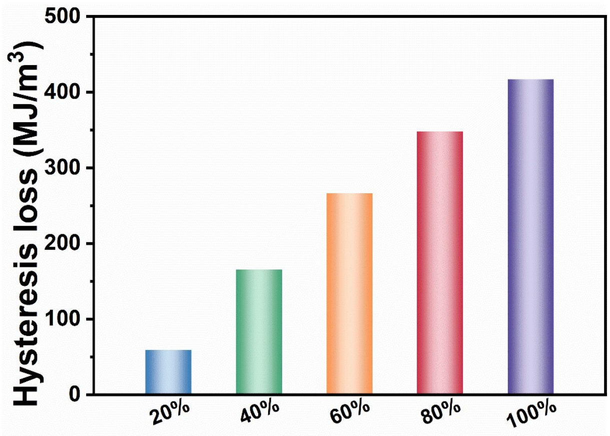

Fig. S7. Hysteresis loss per cycle at different strains.

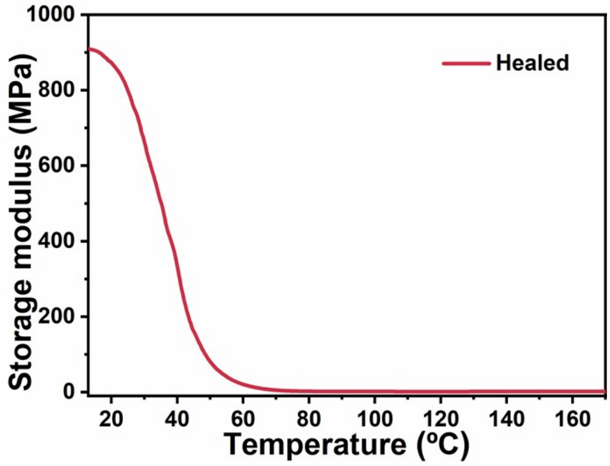

Fig. S8. Storage modulus of scratched ESO/BGAV-3 after self-healing.

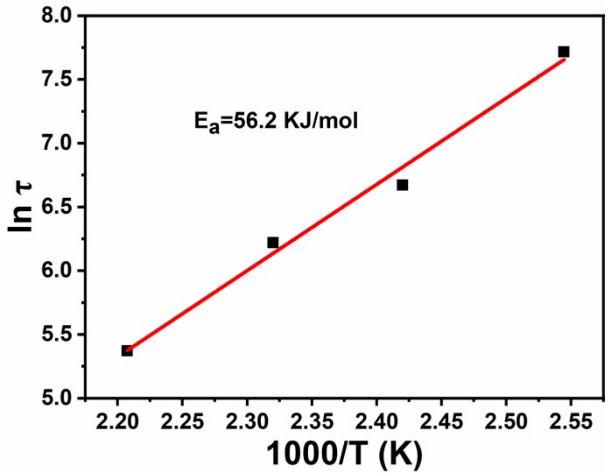

Fig. S9. Linear fitting curve based on the Arrhenius equation (R^2=0.9902).

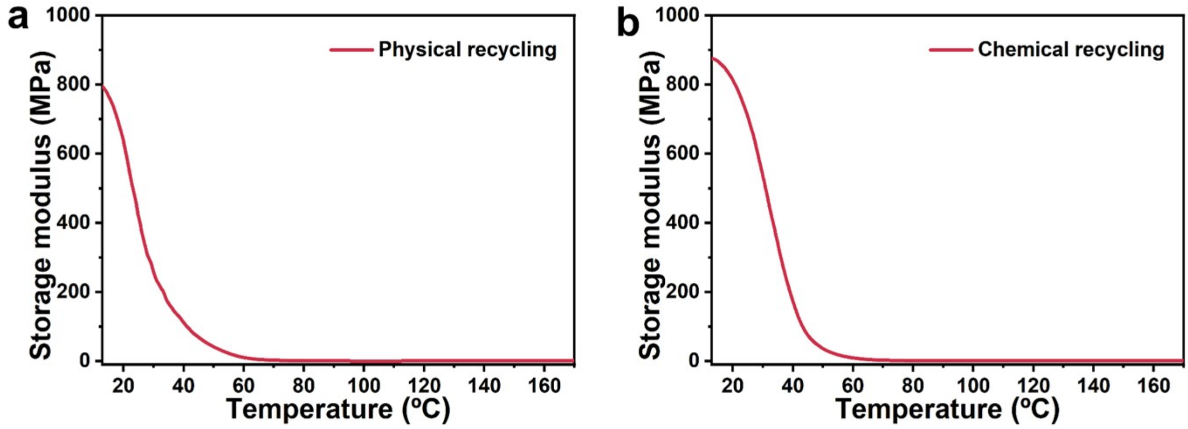

Fig. S10. Storage modulus of ESO/BGAV-3 after (a) physical recycling and (b) chemical recycling.

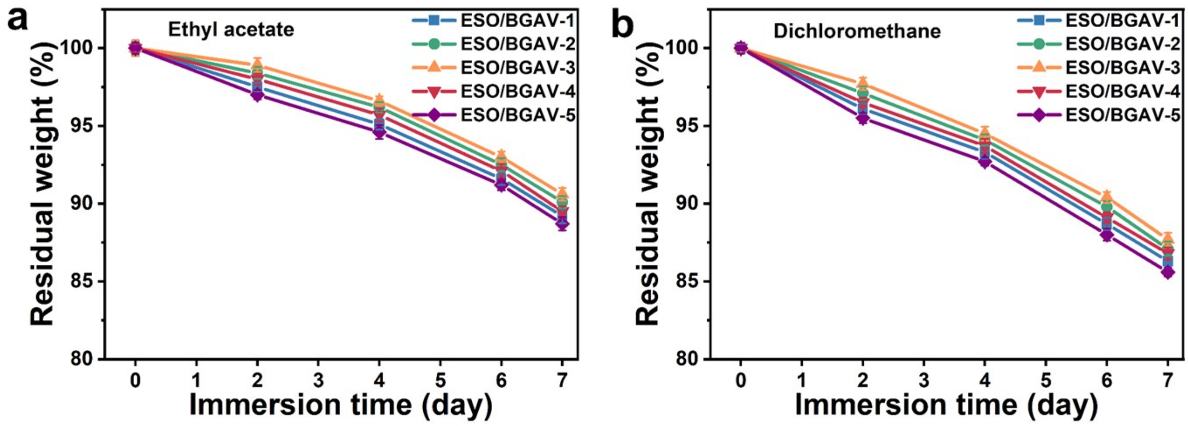

Fig. S11. Change in the residual weight of different ESO/BGAV films with immersion time.

Table S1. Formulations of the ESO/BGAV-1, ESO/BGAV-2, ESO/BGAV-3, ESO/BGAV-4, and ESO/BGAV-5.

Sample	ESO (g)	BGAV (g)	DMAP (g)	1,4-dioxane (mL)
ESO/BGAV-1	1	0.8	0.02	5
ESO/BGAV-2	1	1.0	0.02	5
ESO/BGAV-3	1	1.2	0.02	5
ESO/BGAV-4	1	1.4	0.02	5
ESO/BGAV-5	1	1.6	0.02	5

Table S2. Comparison of bonding strength and wet bonding strength of the ESO/BGAV adhesive with phenolic resin, urea-formaldehyde resin, and other reported bio-based adhesives on wood substrate.

Substances	Bonding strength (MPa)	Wet bonding strength (MPa)	Ref.
ESO/BGAV	7.31	5.36	This work
Phenolic resin	1.70	1.10	Ref. 1[1]
Urea-formaldehyde resin	1.94	0.98	Ref. 2[2]
FPL	1.43	1.20	Ref. 3[3]
Tannin/GDE	1.61	1.19	Ref. 4[4]
SMAP	2.03	1.14	Ref. 5[5]
Starch/DDSA	1.77	1.0	Ref. 6[6]
SP/HBPE/SB	1.94	0.90	Ref. 7[7]
Urea/lignin/glyoxal	1.20	1.05	Ref. 8[8]
SP/AA/CSA	2.03	1.21	Ref. 9[9]
SM/QCP/MoS_2@TA	2.63	1.58	Ref. 10[10]

References

1. Y. Zhang, Z. Liu, Y. C. Xu, J. C. Li, S. Q. Shi, J. Z. Li and Q. Gao, *Chem. Eng. J.*, 2021, **426**, 2424726.

2. J. W. Shao, Q. M. Jing, X. Y. Li, M. W. Shahzad, S. C. Jiang, X. H. Zhang, S. B. Ge, B. B. Xu and J. Z. Li, *Adv. Funct. Mater.*, 2025, **35**, 2424726.

3. G.X. Yang, Z.G. Gong, X.L. Luo, L.H. Chen and L. Shuai, *Nature*, 2023, **621**, 511.

4. X.Y. Chen, A. Pizzi, E. Fredon, C. Gerardin, J.X. Li, X.J. Zhou and G.B. Du, *J. Adhes.*, 2022, **98**, 871-888.

5. S.Q. Chen, Q.H. Wang, J.W. Shao, X.Y. Li, Y.Y. Bian, S.C. Jiang, Z.Q. Cao and J.Z. Li, *ACS Nano*, 2025, **19**, 15876-15885.

6. Y.D. Sun, J.Y. Gu, H.Y. Tan, Y.H. Zhang and P.F. Huo, *Int. J. Biol. Macromol.*, 2018, **112**, 1257-1263.

7. W.D. Gu, F. Li, X.R. Liu, Q. Gao, S.S. Gong, J.Z. Li and S.Q.Q. Shi, *Green Chem.*, 2020, **22**, 1319-1328.

8. H. Younesi-Kordkheili and A. Pizzi, *Eur. J. Wood Wood Prod.*, 2021, **79**, 199-205.

9. H.W. Pang, C. Ma, Y.L. Shen, Y. Sun, J.Z. Li, S.F. Zhang, L.P. Cai and Z.H. Huang, *ACS Appl. Mater. Interfaces*, 2021, **13**, 38732-38744.

10. G.D. Zeng, Y.M. Dong, J. Luo, Y. Zhou, C. Li, K. Li, X.N. Li, and J.Z. Li, *ACS Nano*, 2024, **18**, 9451-9469.