A Mild and Efficient Oxidative Degradation System of Epoxy Thermosets: Full Recovery and Degradation Mechanism

Yuwei Long, Fei Tian, Lan Bai, Wenli An, Xu Zhao, Rongcheng Du, Xuehui Liu, Xuelian Zhou, Shimei Xu*, Yu-Zhong Wang*

Collaborative Innovation Center for Eco-Friendly and Fire-Safety Polymeric Materials (MoE), State Key Laboratory of Polymer Materials Engineering, National Engineering Laboratory of Eco-Friendly Polymeric Materials (Sichuan), College of Chemistry, Sichuan University, Chengdu 610064, China.

E-mail: xushimei@scu.edu.cn；yzwang@scu.edu.cn

Supplementary Information

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Microwave-assisted swelling of epoxy thermoset in NMP

To study the effect of microwave-assisted swelling treatment on the internal structure of the amine-cured epoxy resin (EP), the mercury intrusion test was carried out on the swollen epoxy thermoset (SEP). It can be seen from the mercury injection test results that after NMP swelling treatment, the porosity of the epoxy thermoset reaches 50.46%, while the average pore diameter reaches 313.34 nm. To further explain the effect of swelling pre-treatment on the resin, the glass transition temperature before and after swelling was measured. Tg of the virgin resin is 168.8°C. Because of the dense network structure and the folding of the resin molecules, a higher temperature is needed to make a conversion from the freezing state to the thawing state. After NMP swelling, the glass transition temperature decreased to 158.5°C. The mercury intrusion test showed that nanoholes were formed in the network structure of the resin due to the stretching of the molecular chain in the resin. At the same time. This change also increases the free space between molecules, making the moving unit move more freely and rapidly. Meanwhile, more active sites are exposed, which is conducive to the rapid and efficient degradation reaction.

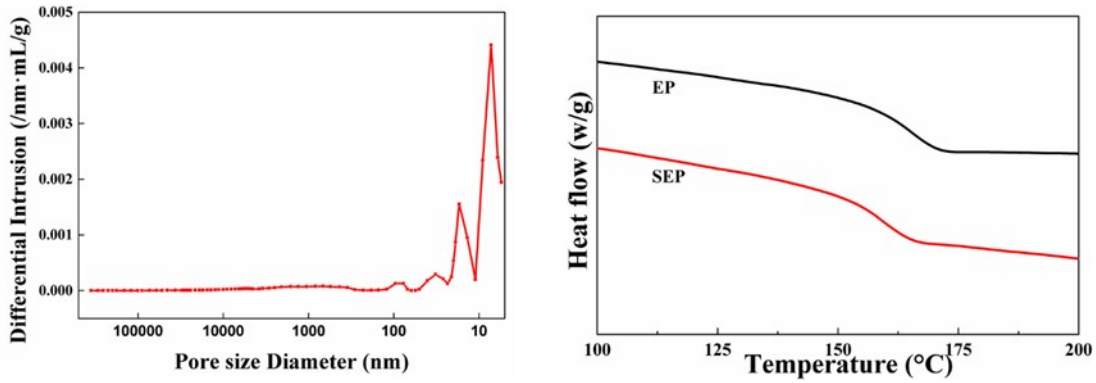


Figure S1 (a) The mercury intrusion test of SEP. (b) The differential scanning calorimetry of EP and SEP

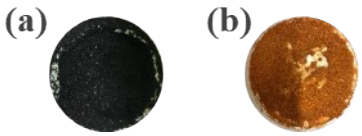
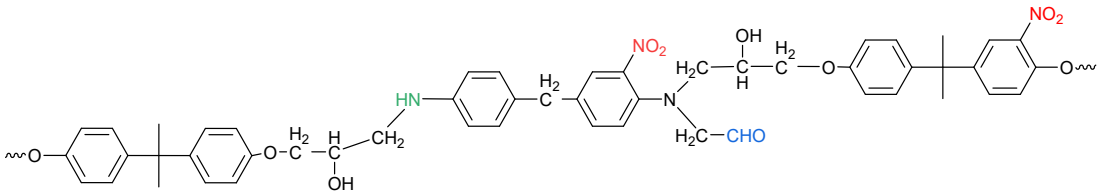


Figure S2 Digital photographs of degradation products with different degradation ratio (a) 40%, (b) 100%



Scheme S1 Repeat unit of DSEP

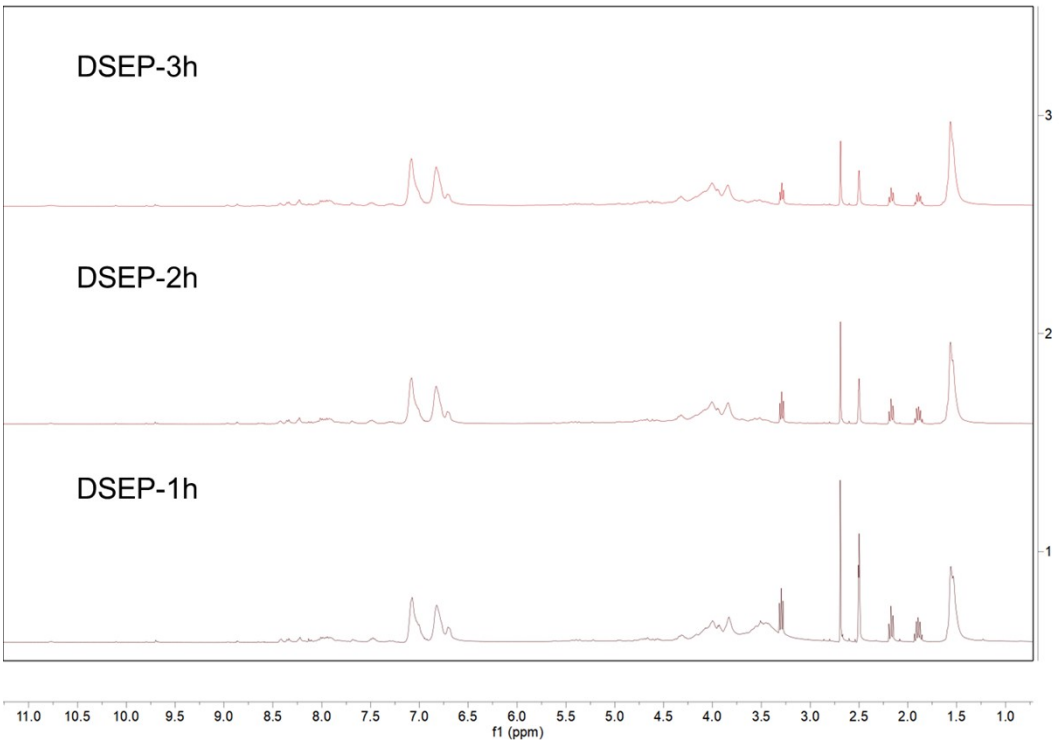


Figure S3 The 1H-NMR of DSEP in different degradation time.

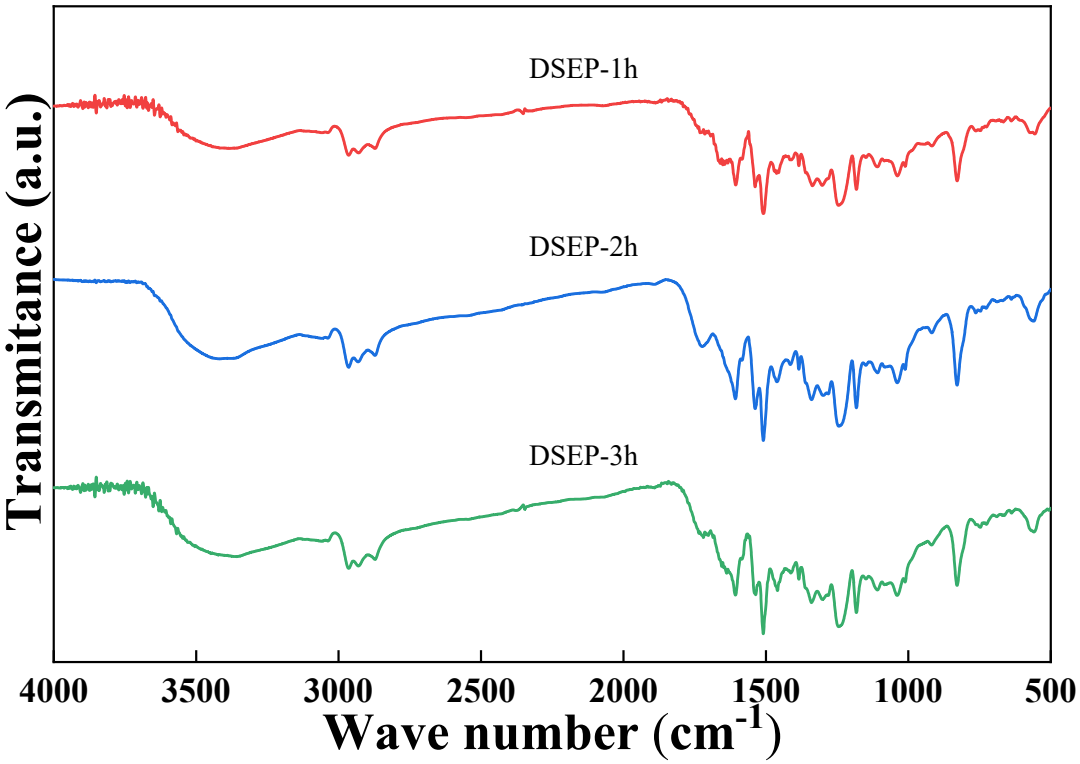


Figure S4 The FTIR spectra of DSEP in different degradation time.

Table S1 The element analysis of EP, SEP, and DSEP.

Sample	C (wt %)	O (wt %)	H (wt %)	N (wt %)
EP	74.94	14.92	7.05	3.09
SEP	71.97	15.42	7.38	5.23
DSEP-1 h	58.62	27.20	5.41	8.77

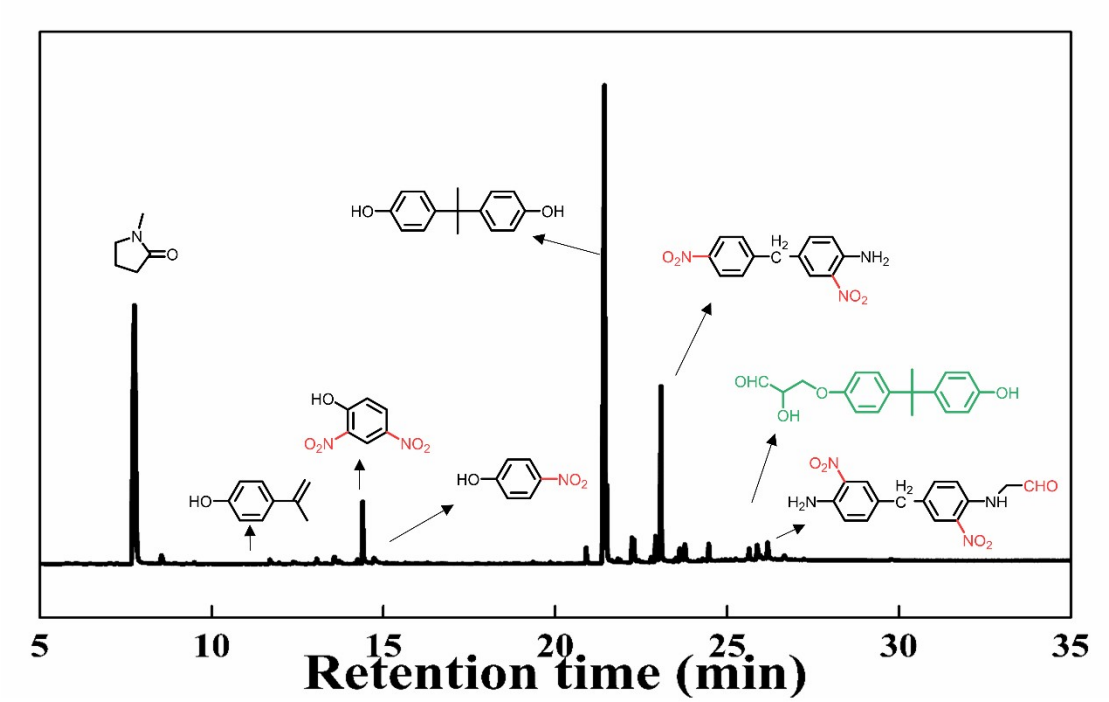
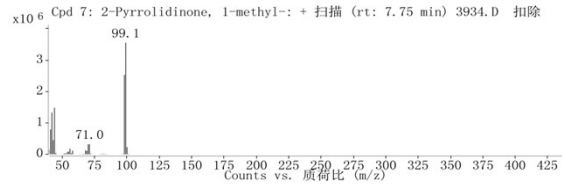
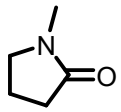
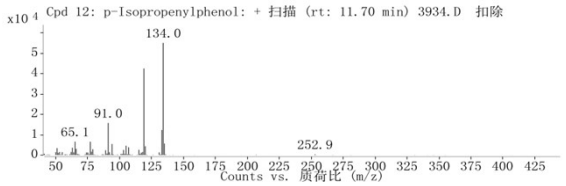
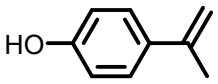
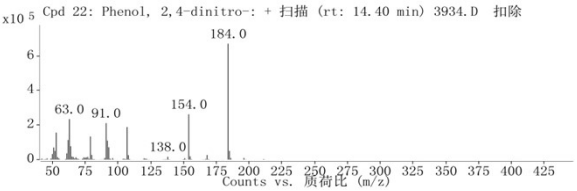
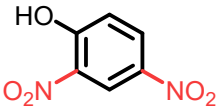
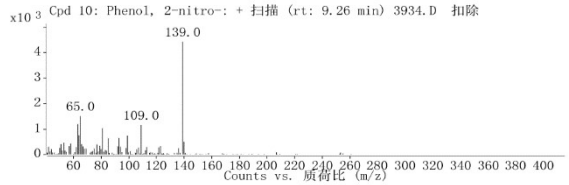
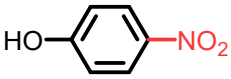
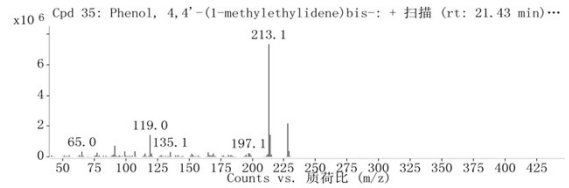
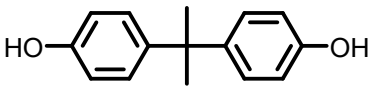
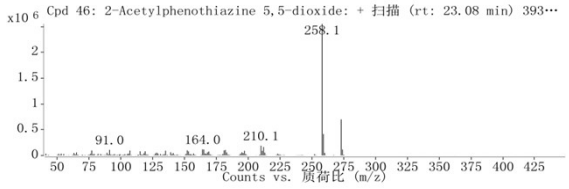
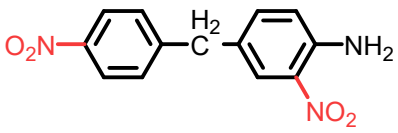
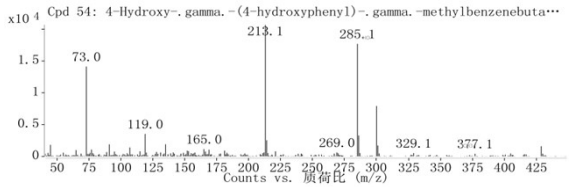
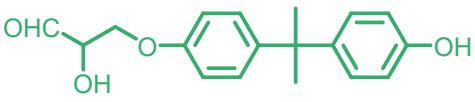
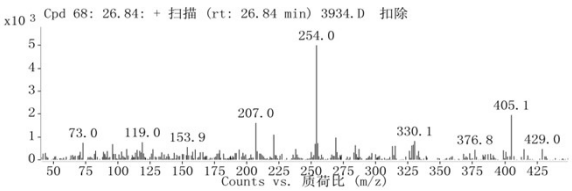
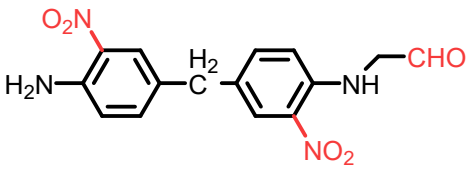
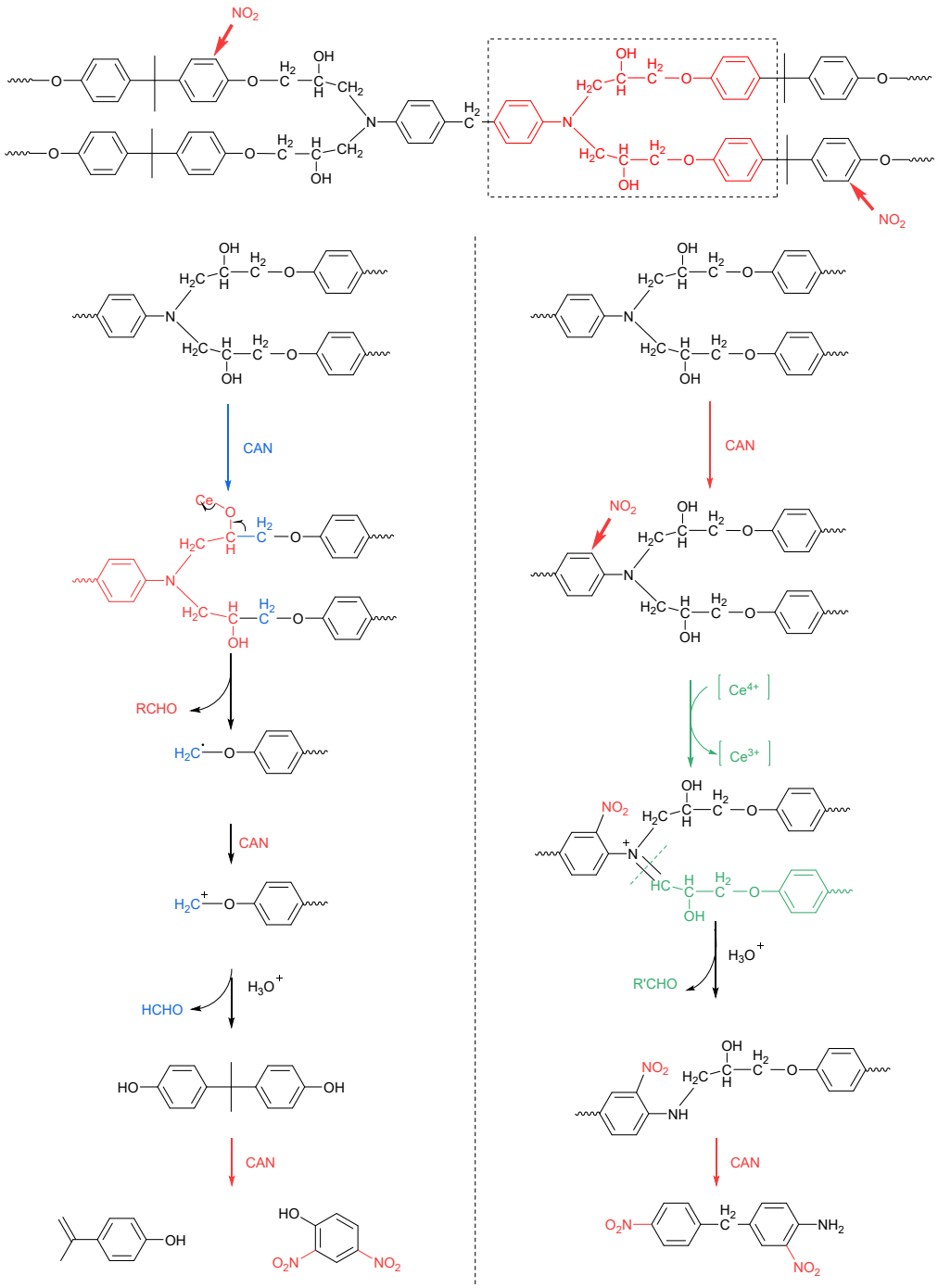


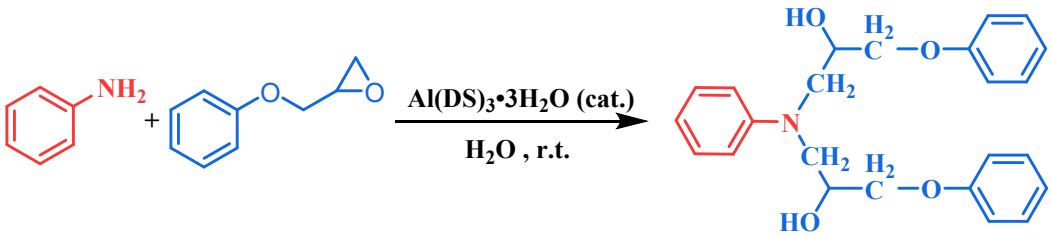
Figure S5 Structure assignment of DSEP soluble in ethyl acetate with different retention time

Table S2 The MS spectrum of DSEP soluble in ethyl acetate

Mass Spectrum	Structure
	
	
	
	
	
	
	
	



Scheme S2 The Proposed mechanism for the production of some small-molecule pieces in the system



Scheme S3 The synthetic pathways of model compounds

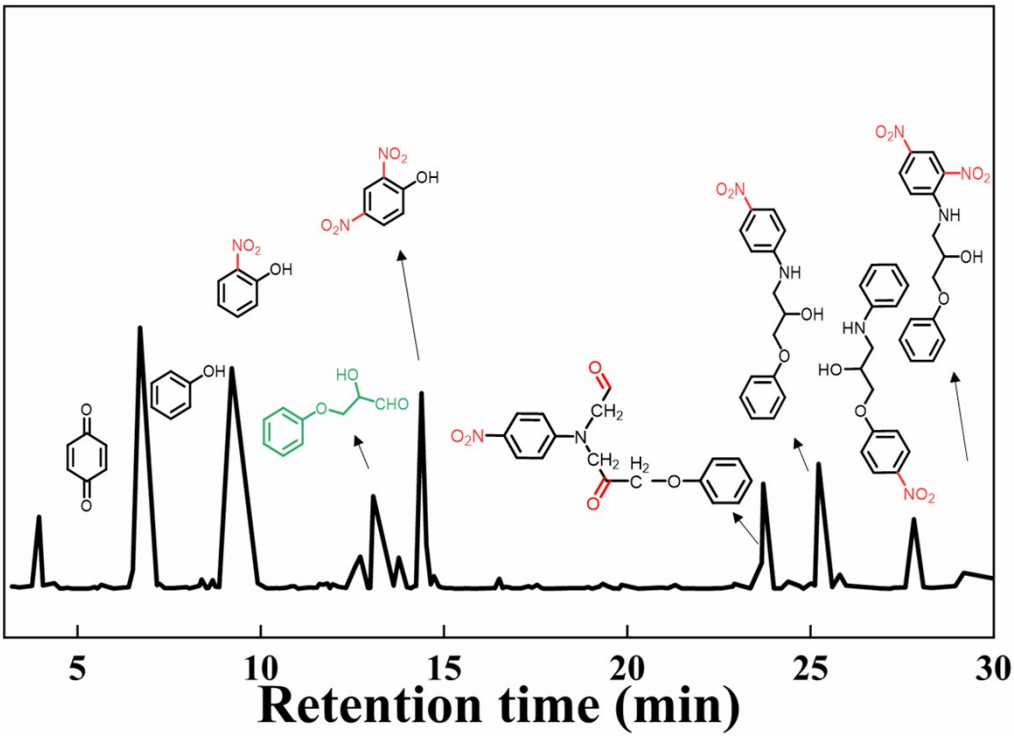
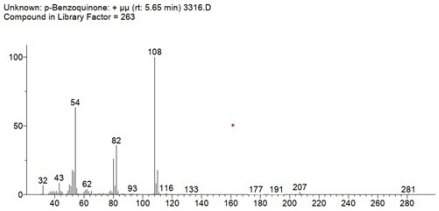
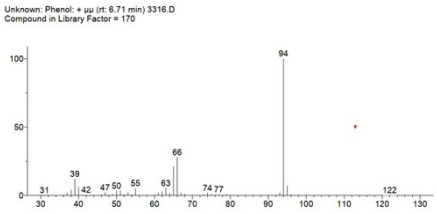
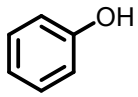
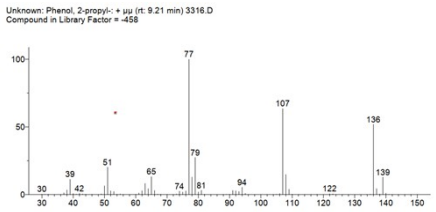
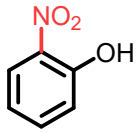
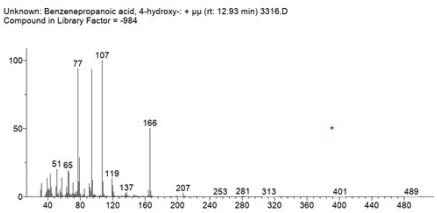
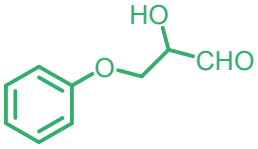
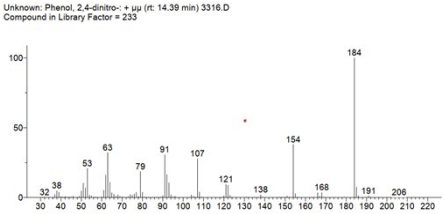
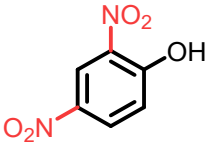
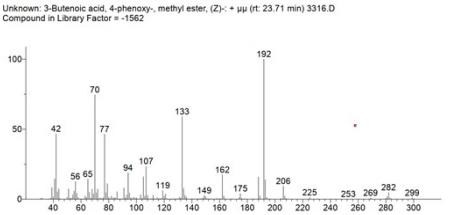
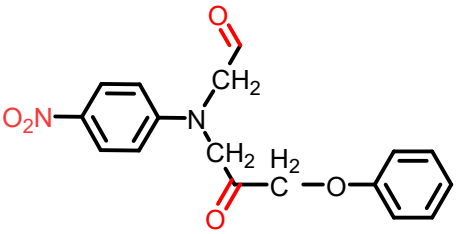
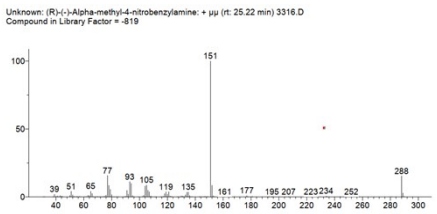
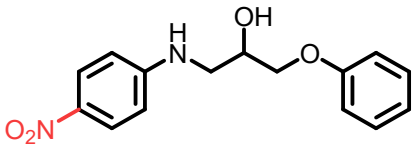
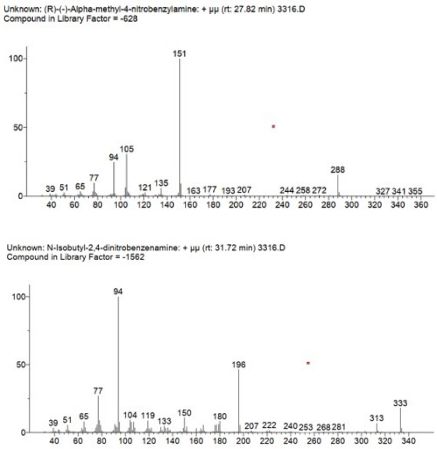


Figure S6 Structure assignment of degradation products of model compounds with different retention time

Table S3 The MS spectrum of degradation products of model compounds

Mass Spectrum	Structure
	
	
	
	
	
	
	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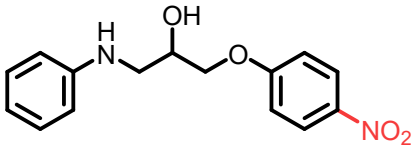
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N
OH
O
NO2

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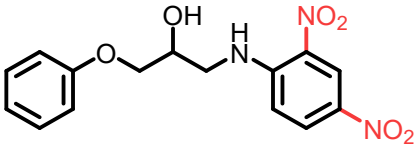
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NO2
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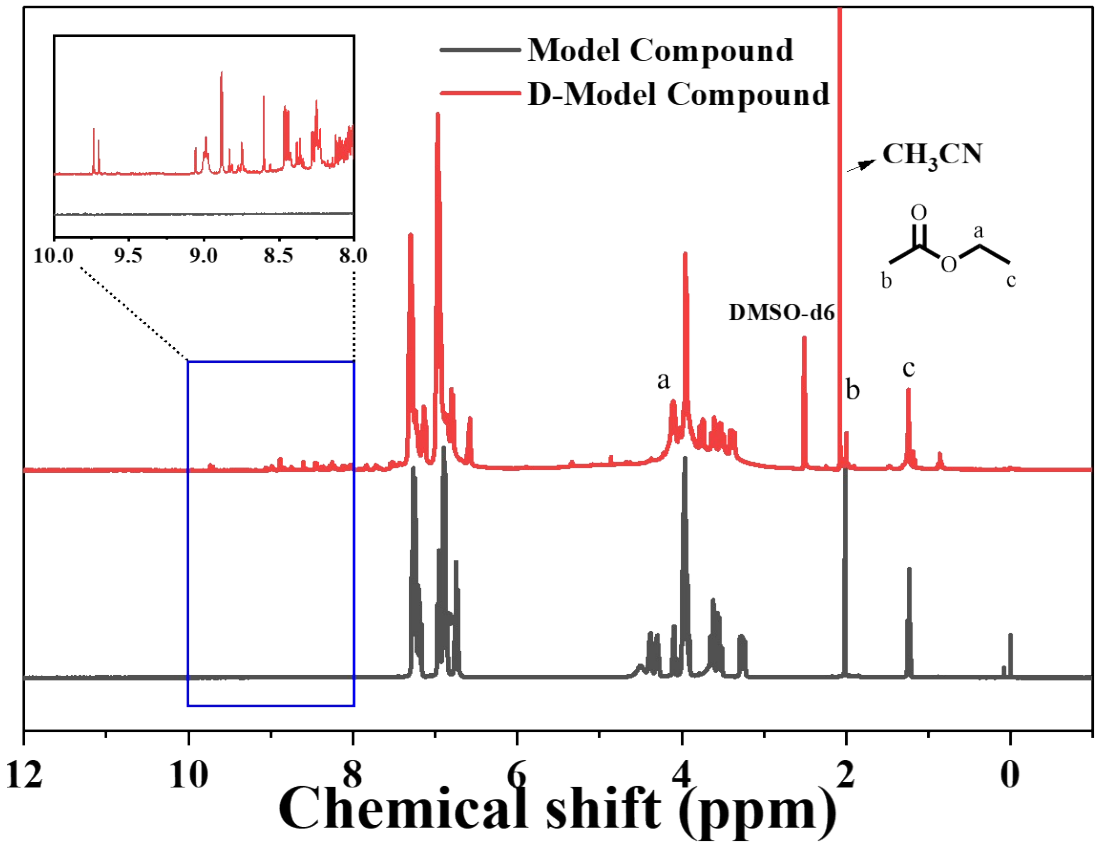

Figure S7 The 1H-NMR of Model Compound and D-Model Compound

Figure S8 Schematic diagram of the full recovery

Preparation of adhesive and samples fabrication

Dry degradation product (3 g) was dissolved in solvent (6 mL) with vigorous stirring for 10 min at room temperature to achieve homogeneous dispersion. Subsequently, the prepared adhesives were used to glue the sheets with 200 g m^{-2} of adhesive coating, followed by curing under pressing provided by two long tail clips (32 mm) for each sample in oven for different time at different temperatures. The obtained samples were then stored under ambient conditions for 24 h.

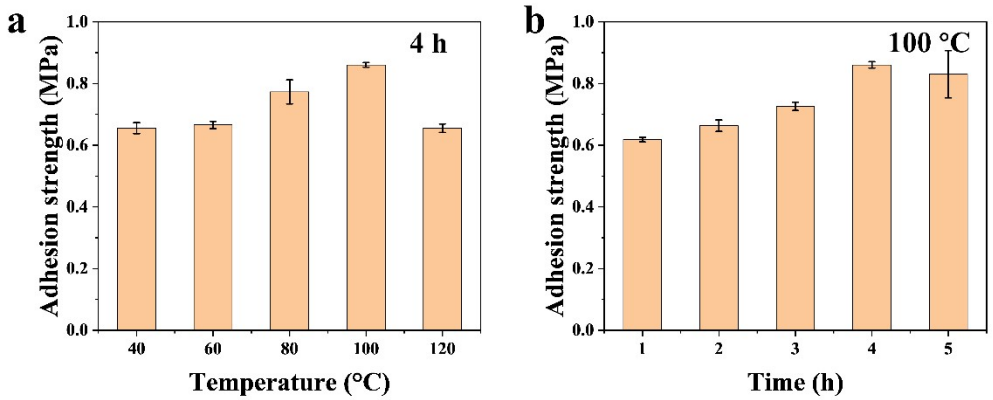

Figure S9 DSEP for bonding wood (a) at different temperatures (b) for different time

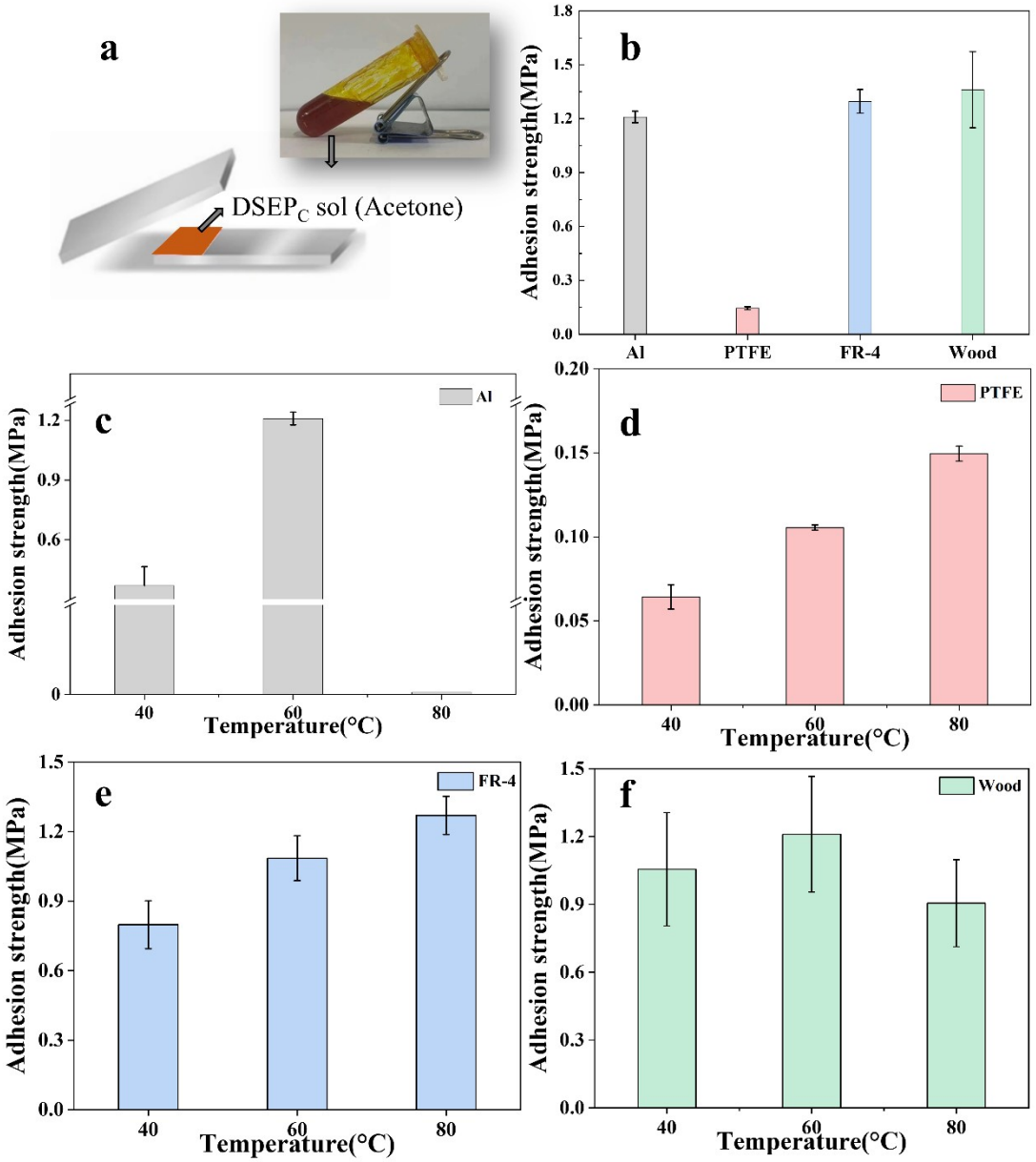

Figure S10 DSEP$_C$ for bonding (a) schematic diagram of bonding experiment (b) adhesion to different substrates (c-f) at different temperatures