

## Support information

### **The carbonate exchange reaction strategy for chemical recycling of poly(bisphenol A carbonate) into epoxy-curing agent**

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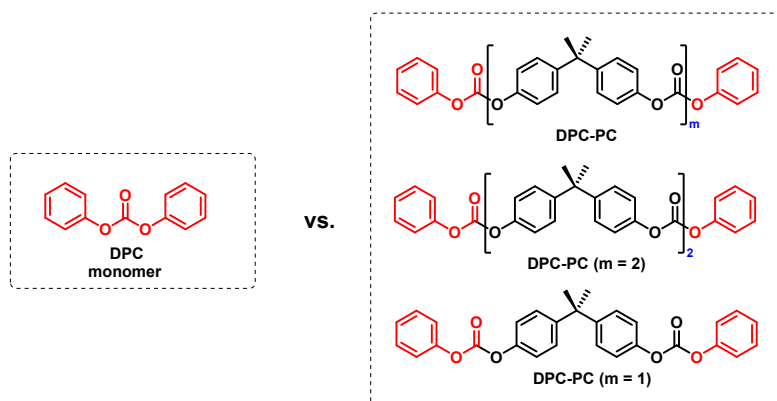
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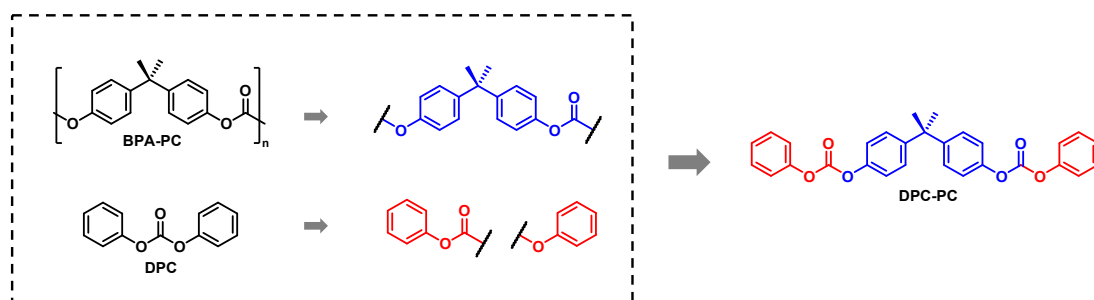
## Instrumentation

Nuclear magnetic resonance measurements (NMR) were performed at room temperature on Bruker Advance instrument at 400 MHz ( $^1\text{H}$  NMR, DOSY) using  $\text{CDCl}_3$  as solvent and TMS as internal reference. Molecular weight ( $M_n$ ) and dispersity ( $\mathcal{D}$ ) of the polymers were determined by size-exclusion chromatography (SEC, Agilent 1260 LC, USA) using THF as the eluent (flow rate: 1 mL/min, 40°C). Polystyrene was used as a reference standard, and the sample concentration was 1 mg/mL. A single PLgel column with a mesh size of 10  $\mu\text{m}$  and dimensions of 7.5  $\times$  300 mm was used, and the detector employed was a refractive index detector (RID). DSC measurements were performed on DSC 3500 Sirius (NETZSCH). The instrument was operated in the standard DSC mode and was calibrated with an indium standard. Measurements were performed under  $\text{N}_2$  atmosphere with a flow rate of 20 mL/min. Each sample with a mass of 10 mg was used for the measurement. The typical procedures for the measurements of samples were as follows: in the first heating scan, samples were heated from 20°C to 300°C at a heating rate of 10 K/min and kept at 300°C for 10 min. In the second heating scan, samples were cooled to 0°C at 10 K/min and kept at 0°C for 10 min to eliminate any thermal history, and subsequently reheated to 300°C at 10 K/min. Thermogravimetric analyses (TGA) were performed on Mettler Toledo TGA/DSC 3+, 5 mg sample was loaded in a crucible and heated from 30 to 800°C with a rate of 10 K/min under Ar stream, the mass loss of samples were recorded as the temperature increasing. High resolution mass spectrometry analysis was conducted on Bruker Maxis UHR TOF, using  $\text{CHCl}_3$  as solvent. Fourier transform infrared (FTIR) spectroscopy were conducted on Bruker Vertex80V and scanned from 400  $\text{cm}^{-1}$  to 4000  $\text{cm}^{-1}$  using a spectrophotometer equipped with an ATR probe. The samples were cut into dumbbell-like shape with a dimension of 35 mm  $\times$  2 mm  $\times$  0.4 mm for uniaxial tensile test, and the test was carried out on KEZHUN Test Instruments (KZ-SSBC-500) at room temperature with a stretch rate of 2 mm/min. The dynamic mechanical properties (DMA) and stress relaxation were both measured on TA Discovery DMA850. For DMA test, the samples were cut into flake-like shape with a dimension of 15 mm  $\times$  4 mm  $\times$  1 mm before test, and then the test performed under a scanning

from 20-200°C, with heating rate of 3°C/min, amplitude was set to 10 μm and frequency was 1 Hz. For stress relaxation, the samples were cut into the same dimension with DMA testing. The samples were heated to the required temperature and balanced for 10 min, and displacement was set to 10 μm, relaxation time was set to 10 min.



Scheme S1. Chemical structure of DPC and DPC-PC.



Scheme S2. The theoretical products when BPA-PC was reacted with an equivalent amount of DPC.

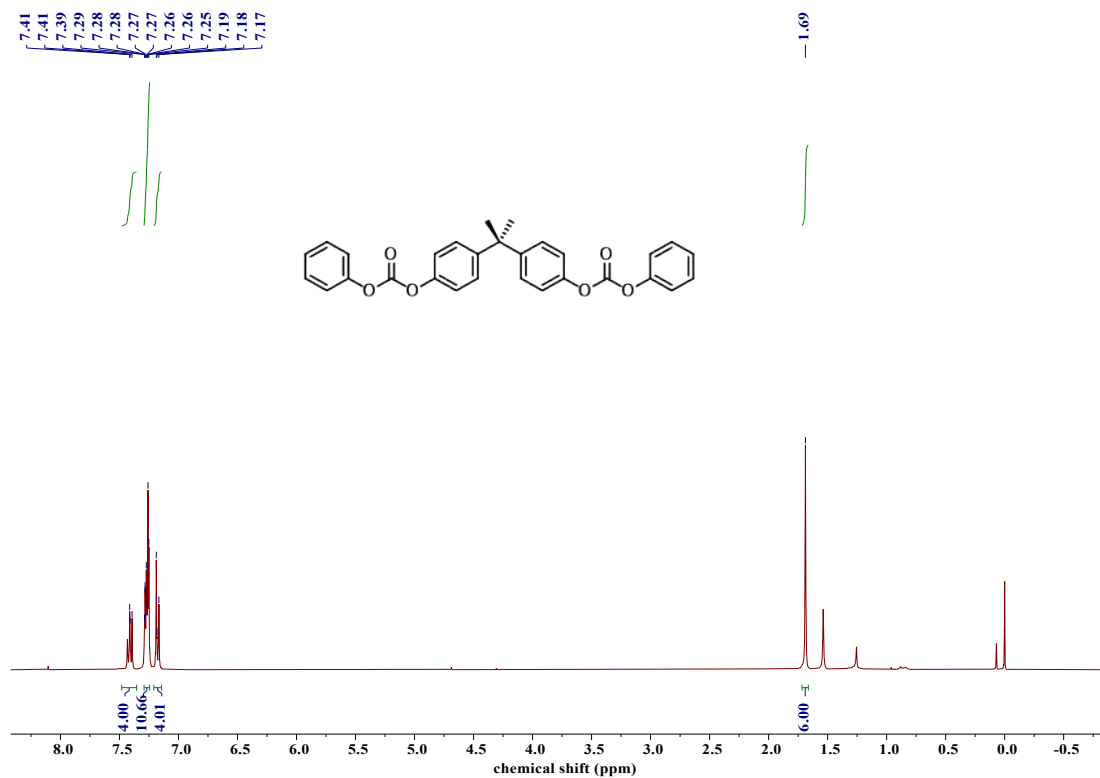


Figure S1. <sup>1</sup>H NMR spectrum of DPC-PC (m = 1) (400 MHz, Chloroform-*d*, 298 K).

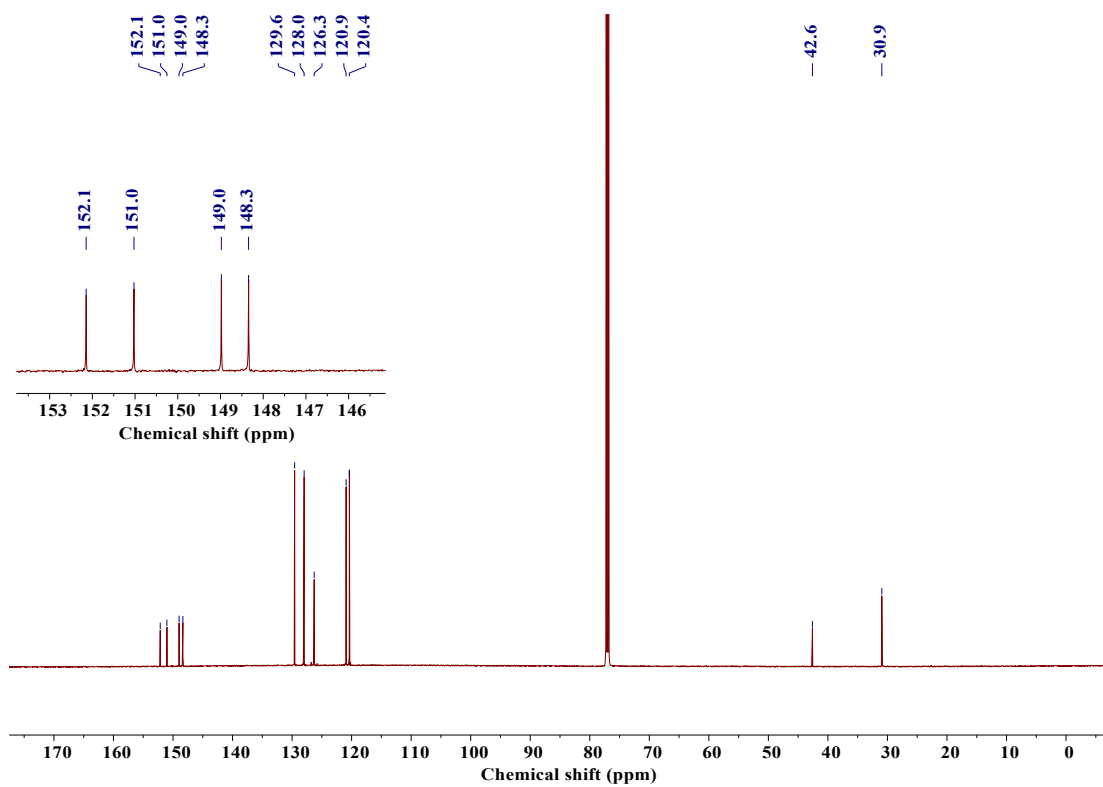
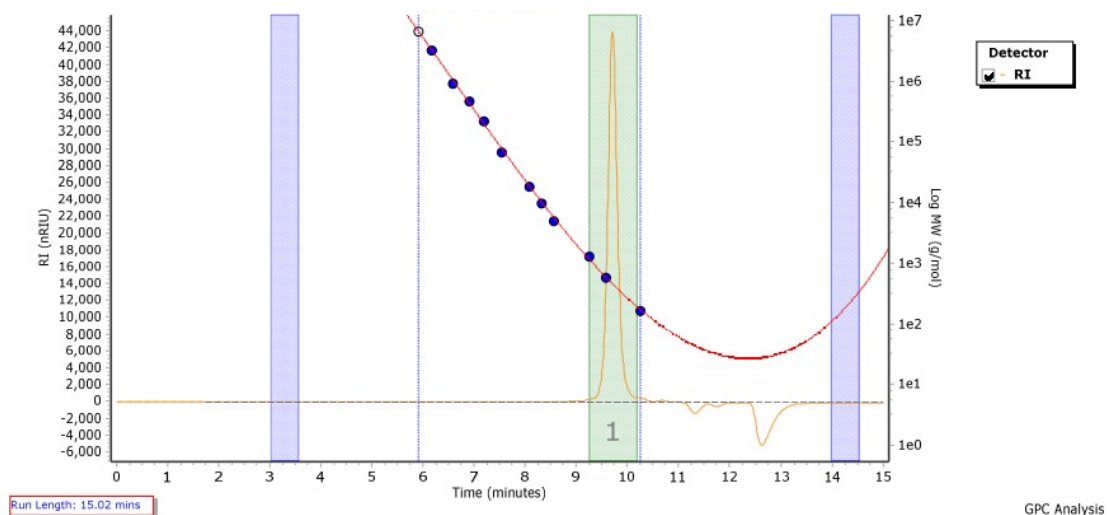


Figure S2. <sup>13</sup>C NMR spectrum of DPC-PC (m = 1) (100 MHz, Chloroform-*d*, 298 K).



**Molecular Weight Averages**

Peak	Mp (g/mol)	Mn (g/mol)	Mw (g/mol)	Mz (g/mol)	Mz+1 (g/mol)	Mv (g/mol)	PD
Peak 1	452	434	455	477	503	474	1.048

Figure S3. SEC trace of DPC-PC ( $m = 1$ ).

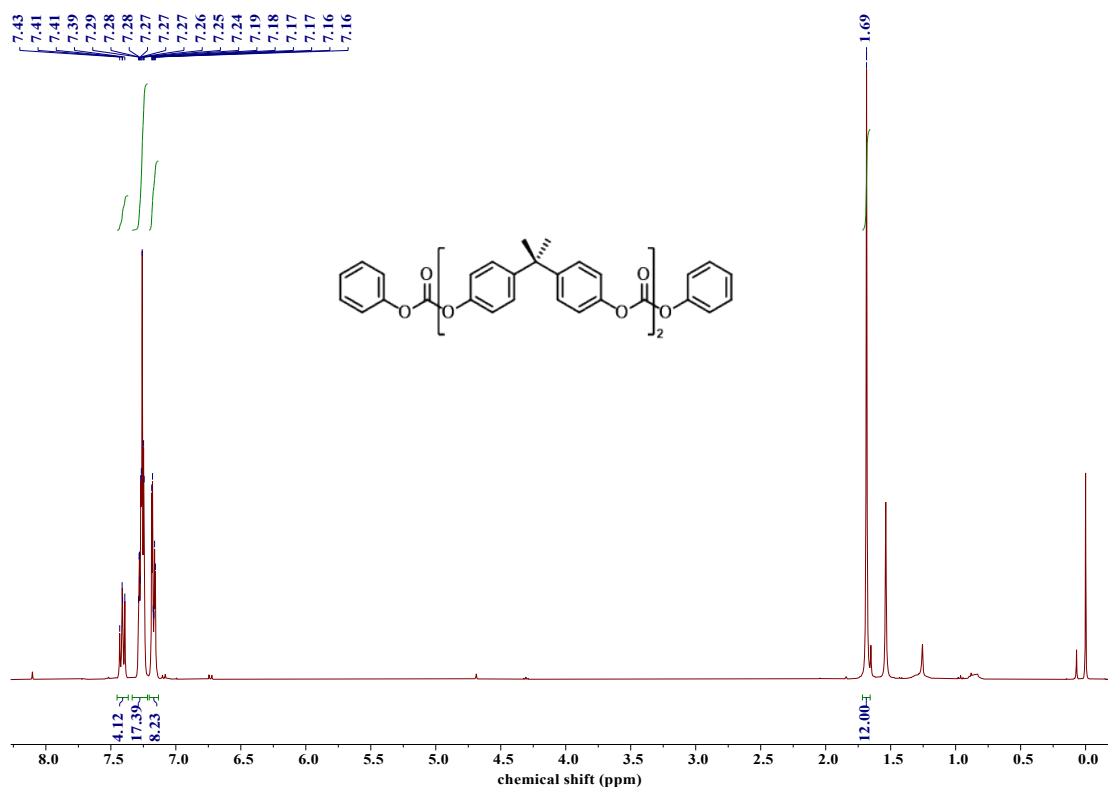


Figure S4.  $^1\text{H}$  NMR spectrum of DPC-PC dimer ( $m = 2$ ) (400 MHz, Chloroform- $d$ , 298 K).

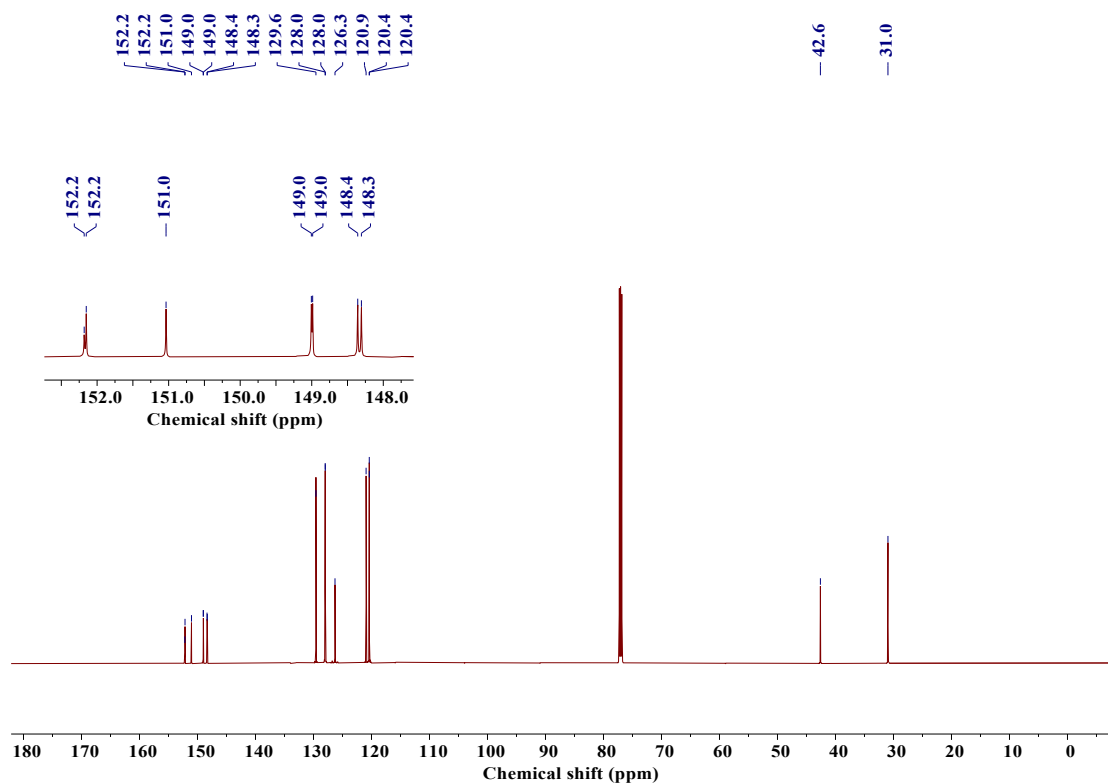
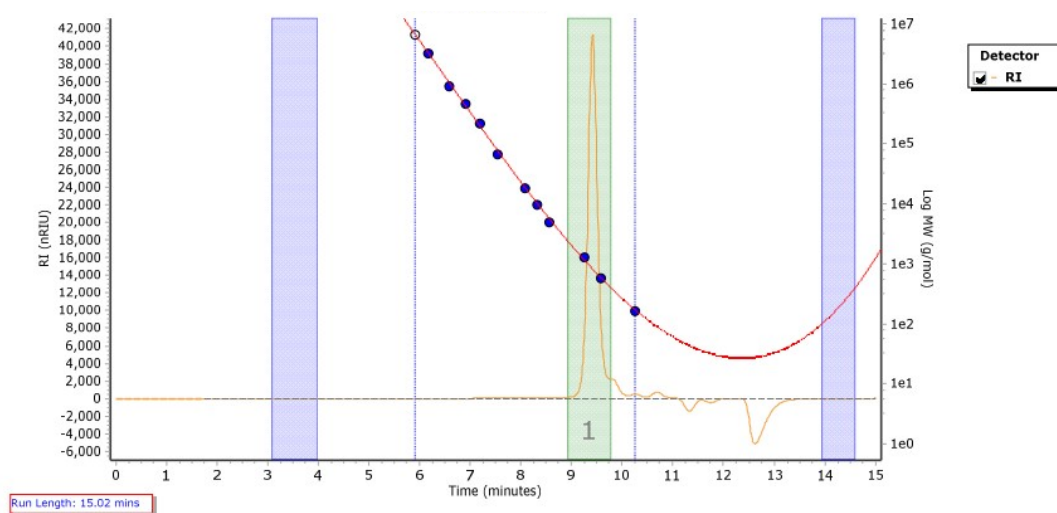


Figure S5.  $^{13}\text{C}$  NMR spectrum of DPC-PC dimer ( $m = 2$ ) (100 MHz, Chloroform- $d$ , 298 K).



**Molecular Weight Averages**

Peak	Mp (g/mol)	Mn (g/mol)	Mw (g/mol)	Mz (g/mol)	Mz+1 (g/mol)	Mv (g/mol)	PD	
Peak 1		812	770	812	856	908	849	1.055

Figure S6. SEC trace of DPC-PC dimer ( $m = 2$ ).

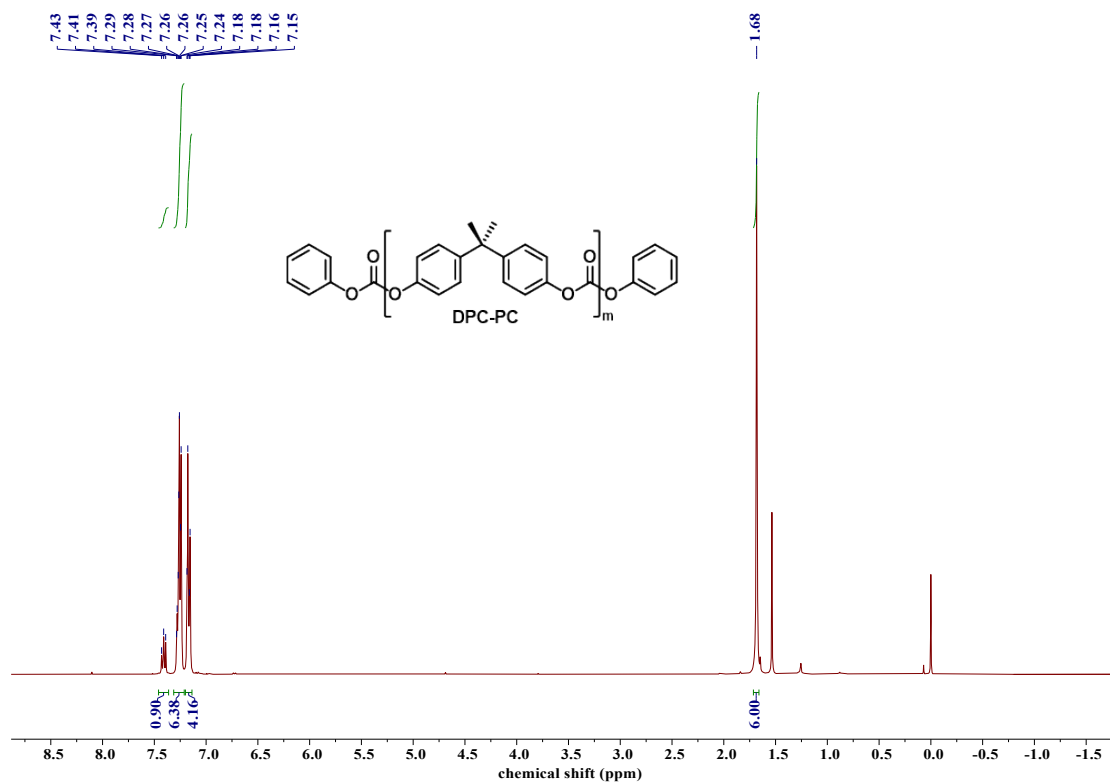
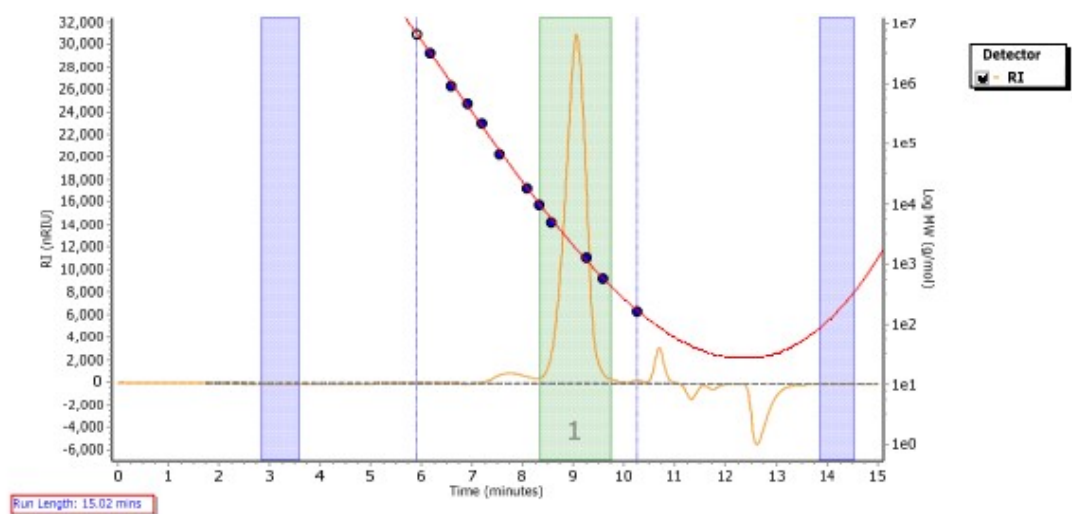


Figure S7.  $^1\text{H}$  NMR spectrum of DPC-PC multimers ( $m = 3-5$ ) (400 MHz, Chloroform- $d$ , 298 K).



**Molecular Weight Averages**

Peak	Mp (g/mol)	Mn (g/mol)	Mw (g/mol)	Mz (g/mol)	Mz+1 (g/mol)	Mv (g/mol)	PD
Peak 1	1759	1676	2087	2677	3507	2572	1.245

Figure S8. SEC trace of DPC-PC multimers ( $m = 3-5$ ).

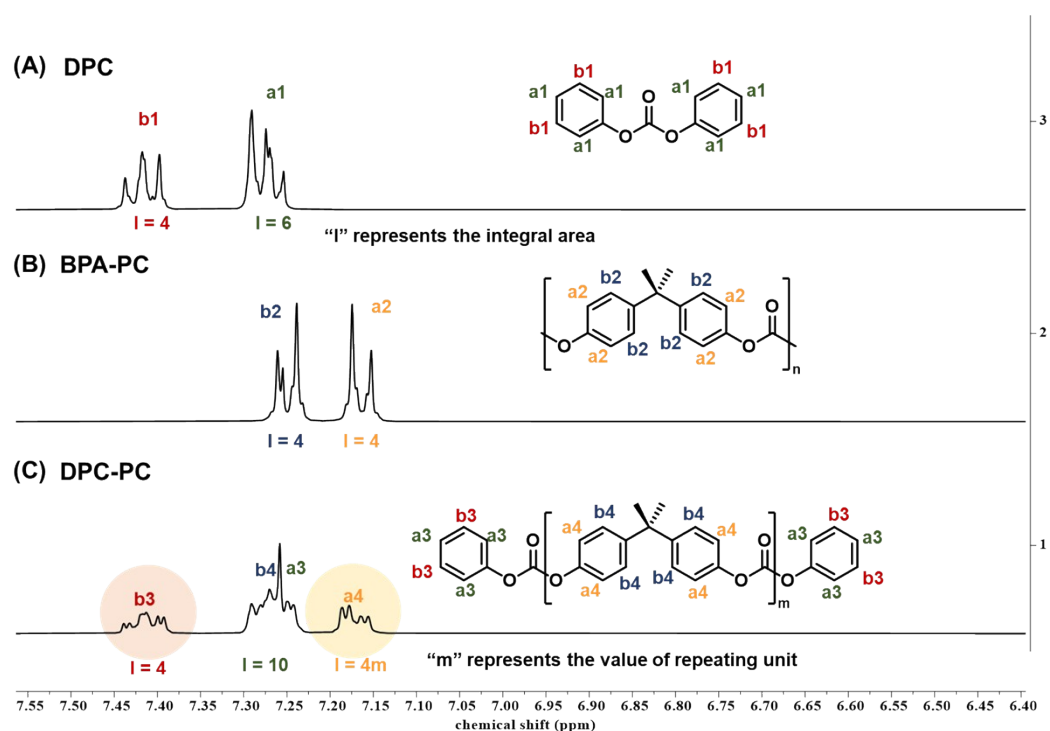


Figure S9. Calculation for the “m” value of DPC-PC.

As depicted in Fig. S7, the peaks with the chemical shift around 7.10-7.50 represent the protons on phenyl of DPC and BPA units. The corresponding attribution was marked on the spectra. According to the analysis of Fig. S7(A), the peaks at 7.25-7.30 ppm are attributed to the six protons “a1” in the ortho and para positions of the carbonate on the aryl ring. While the peaks at 7.40-7.45 ppm are attributed to the four protons “b1” in the meta position. When the integral area of region “a1” is 4, the corresponding integral area of region “b1” should be 6. Meanwhile, in each repeating unit of BPA-PC, the aromatic protons on the bisphenol A structure can be assigned to “a2” and “b2”, respectively, with four hydrogen atoms in each group of peaks (Fig. S7(B)).

Based on the above analysis, the <sup>1</sup>H NMR spectra of the obtained products DPC-PC were compared with DPC and BPA-PC (Fig. S7(C)). Due to their similar structures, the chemical shifts of each proton in DPC-PC could be determined. It could be observed that the peaks at 7.40-7.45 ppm can only be attributed to the four protons “b3” of the terminated phenyl carbonates, while the peaks at 7.15-7.20 ppm can only be attributed to the protons “a4” of the internal BPA repeating units. Therefore, the average value of



“m” (repeating unit number) in DPC-PC products were obtained based on the ratio of their integrated areas, which were calculated through the following formula  $m = I_{a4}/I_{b3}$ . Subsequently, molecular weights of DPC-PC products were obtained as well.

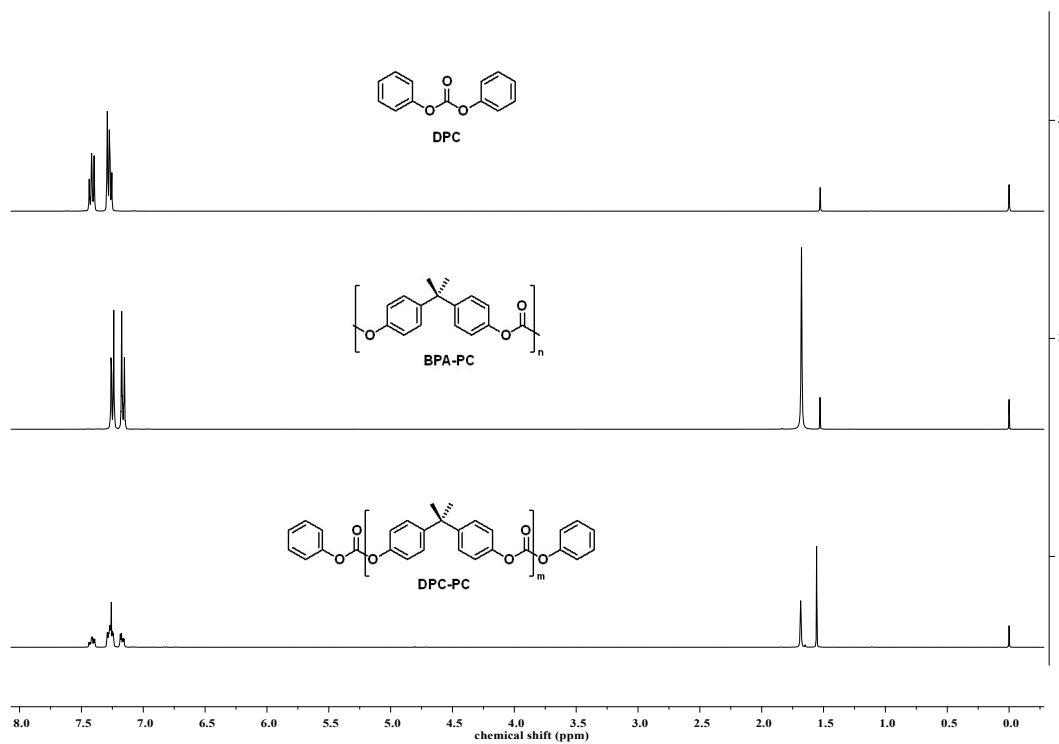


Figure S10.  $^1\text{H}$  NMR spectra of DPC, BPA-PC and DPC-PC.

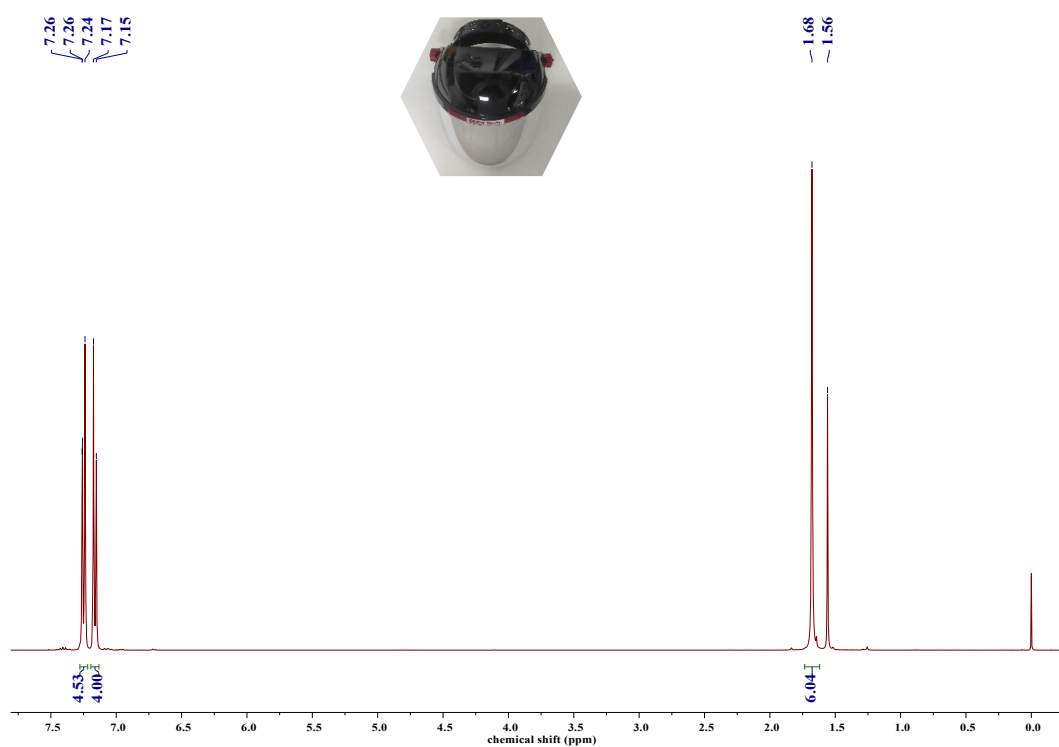


Figure S9.  $^1\text{H}$  NMR spectrum of BPA-PC veil (400 MHz, Chloroform-*d*, 298 K, peak at 1.56 ppm: residual water).

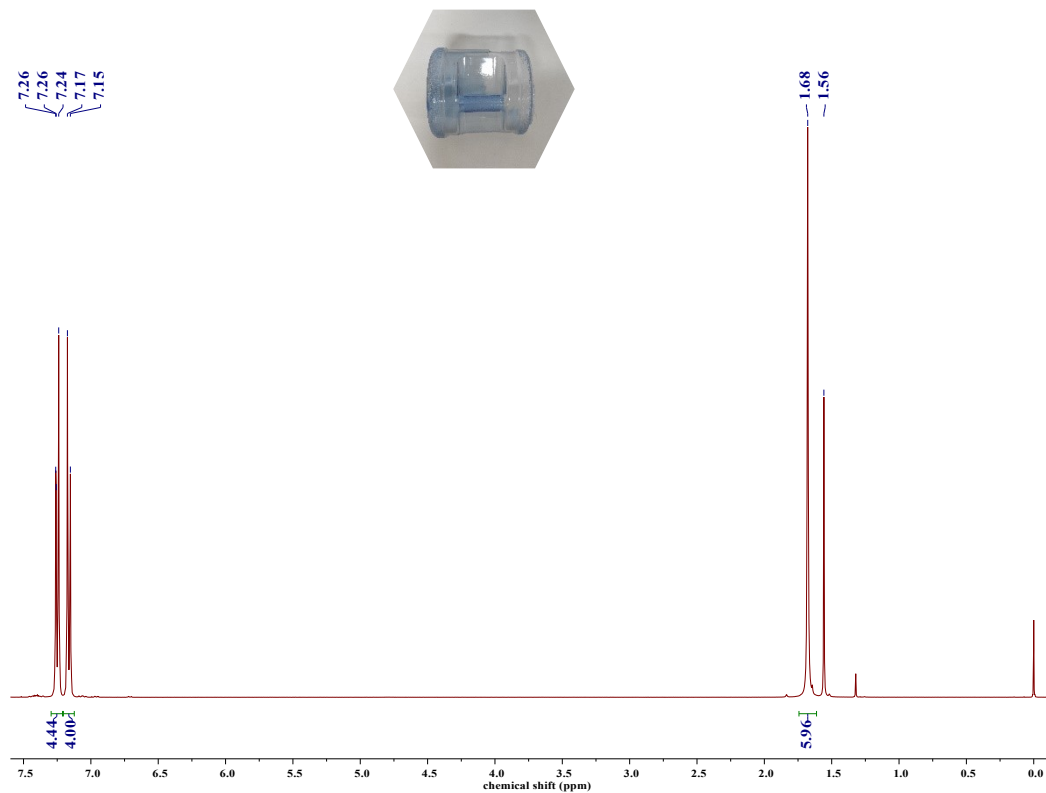


Figure S12.  $^1\text{H}$  NMR spectrum of BPA-PC bucket (400 MHz, Chloroform-*d*, 298 K, peak at 1.56 ppm: residual water).

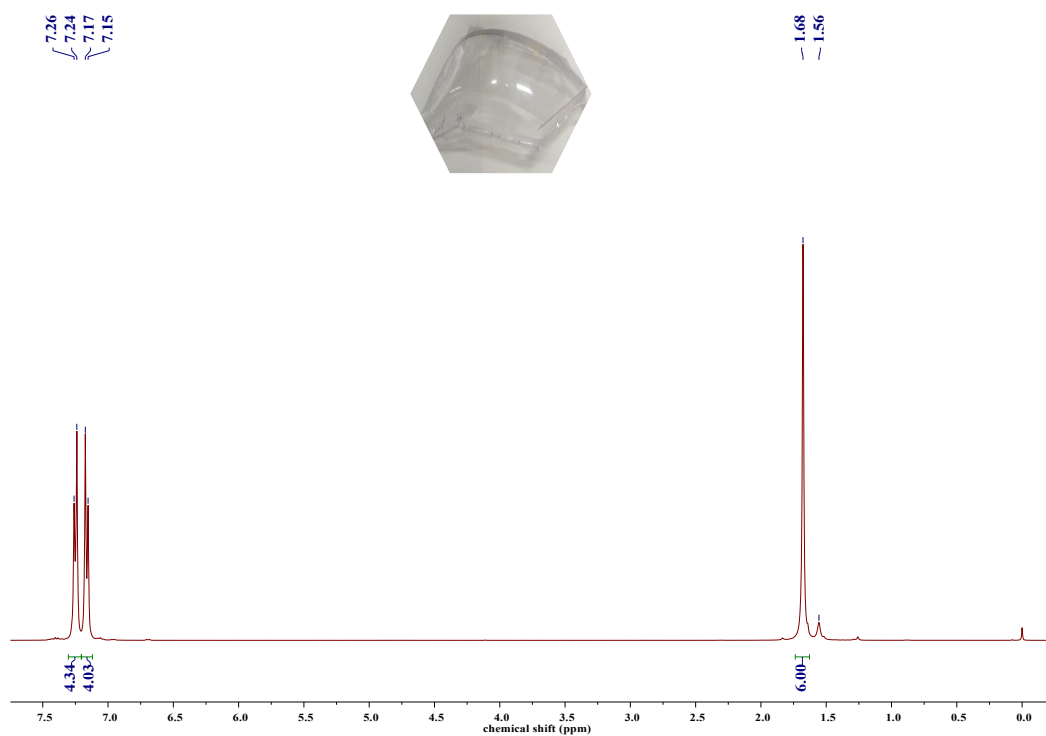


Figure S13. <sup>1</sup>H NMR spectrum of BPA-PC lampshade (400 MHz, Chloroform-*d*, 298 K, peak at 1.56 ppm: residual water).

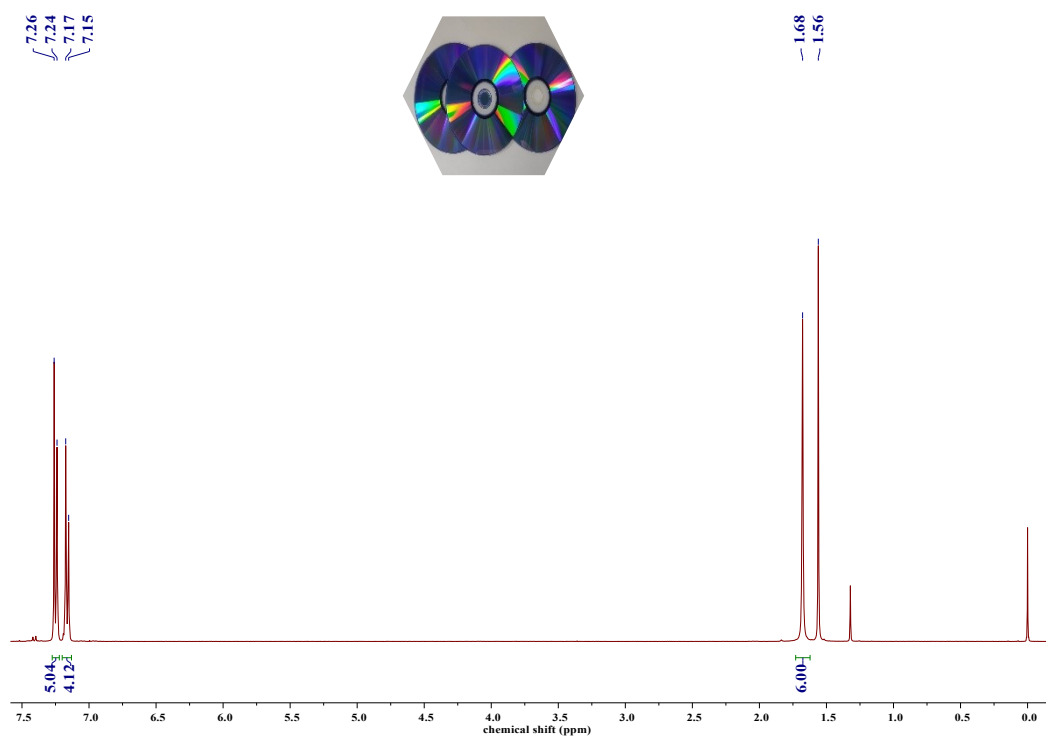


Figure S14. <sup>1</sup>H NMR spectrum of BPA-PC disk (400 MHz, Chloroform-*d*, 298 K, peak at 1.56 ppm: residual water).

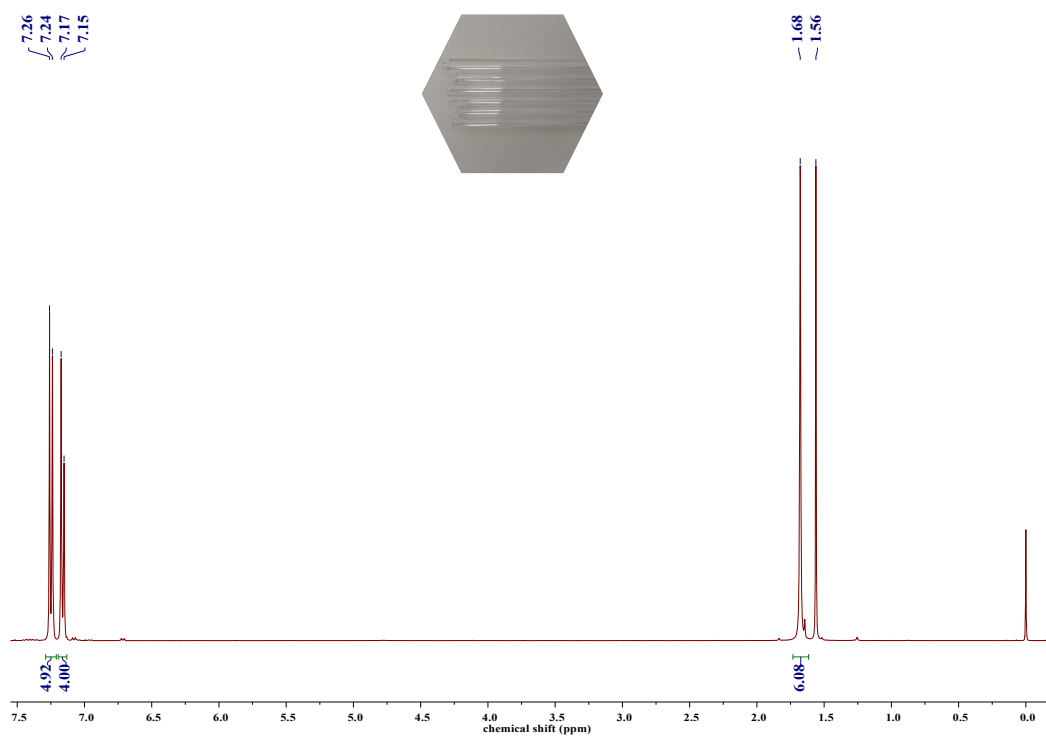


Figure S15. <sup>1</sup>H NMR spectrum of BPA-PC tube (400 MHz, Chloroform-*d*, 298 K, peak at 1.56 ppm: residual water).

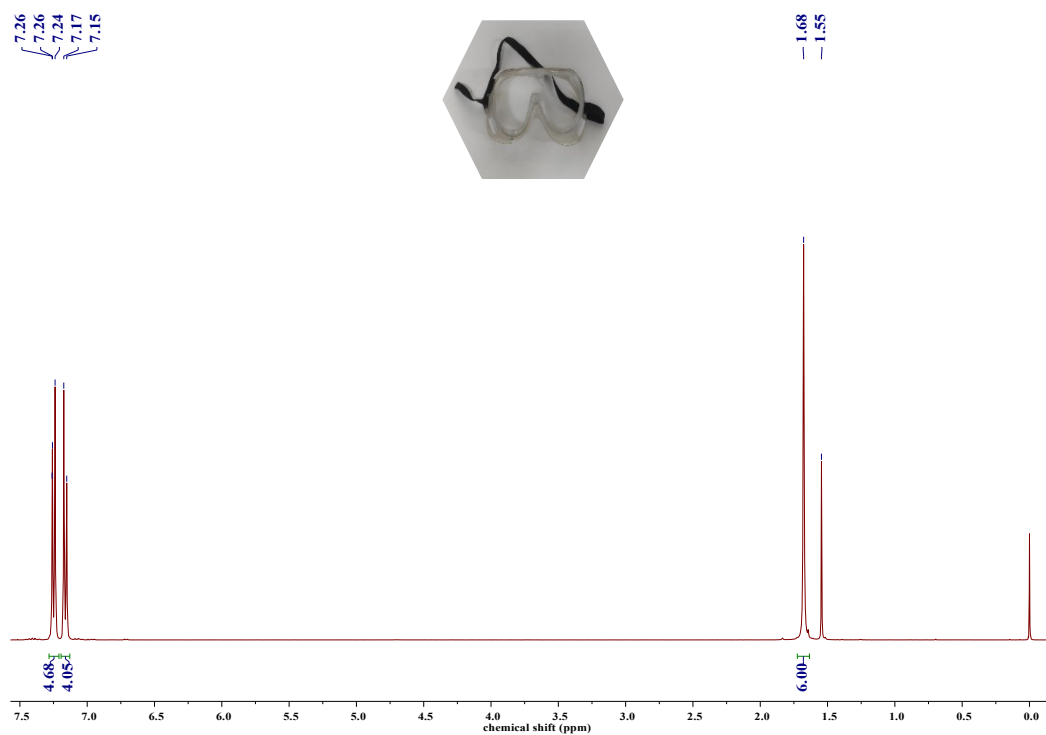


Figure S16. <sup>1</sup>H NMR spectrum of BPA-PC goggle (400 MHz, Chloroform-*d*, 298 K, peak at 1.55 ppm: residual water).

### Chromatogram Plot

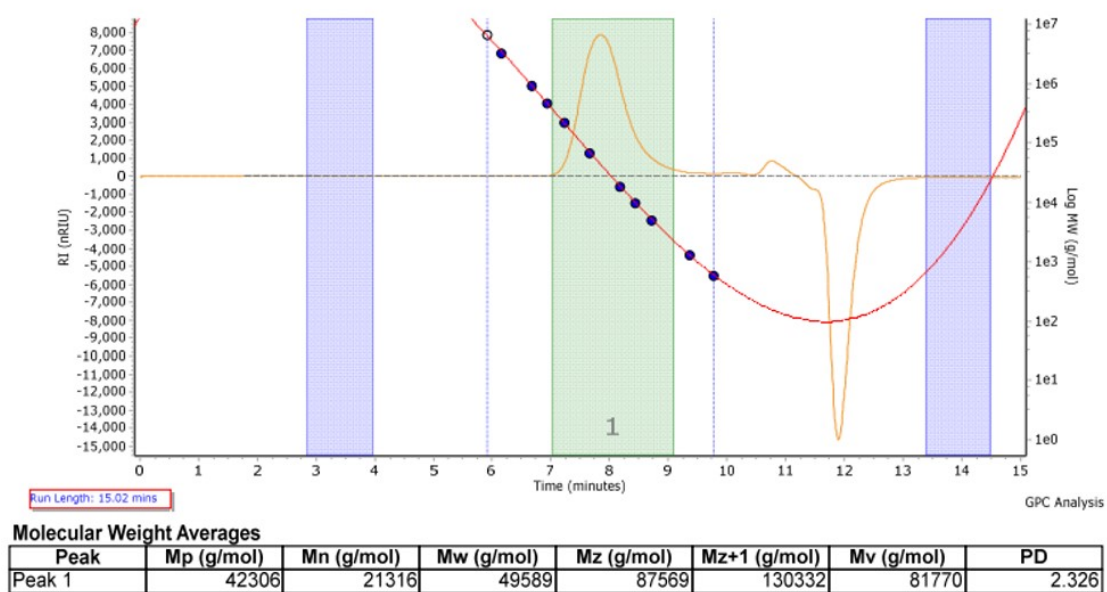


Figure S17. SEC analysis of BPA-PC veil.

### Chromatogram Plot

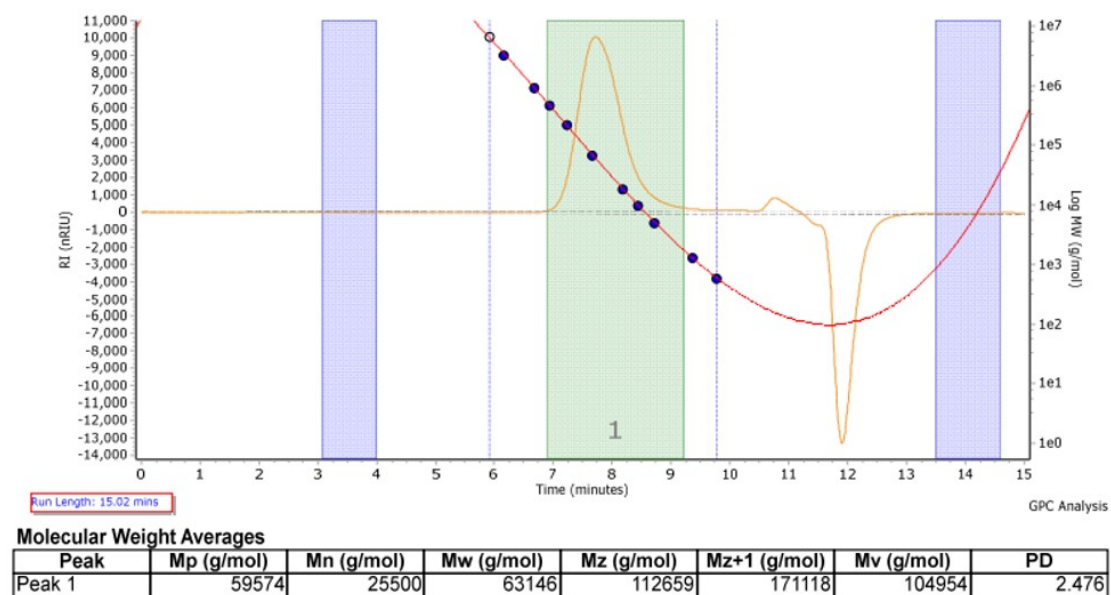
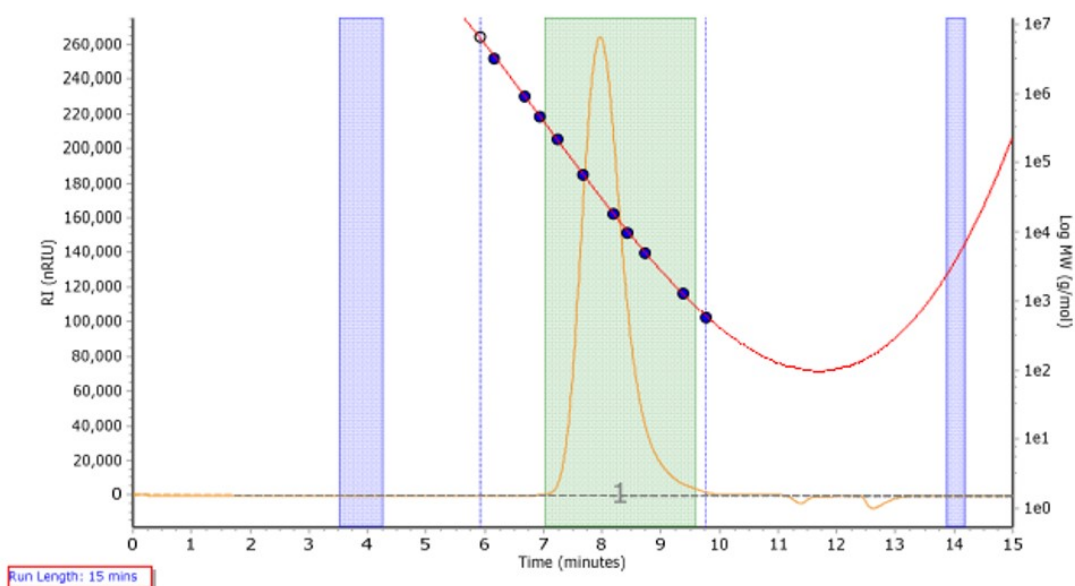


Figure S18. SEC analysis of BPA-PC bucket.

### Chromatogram Plot

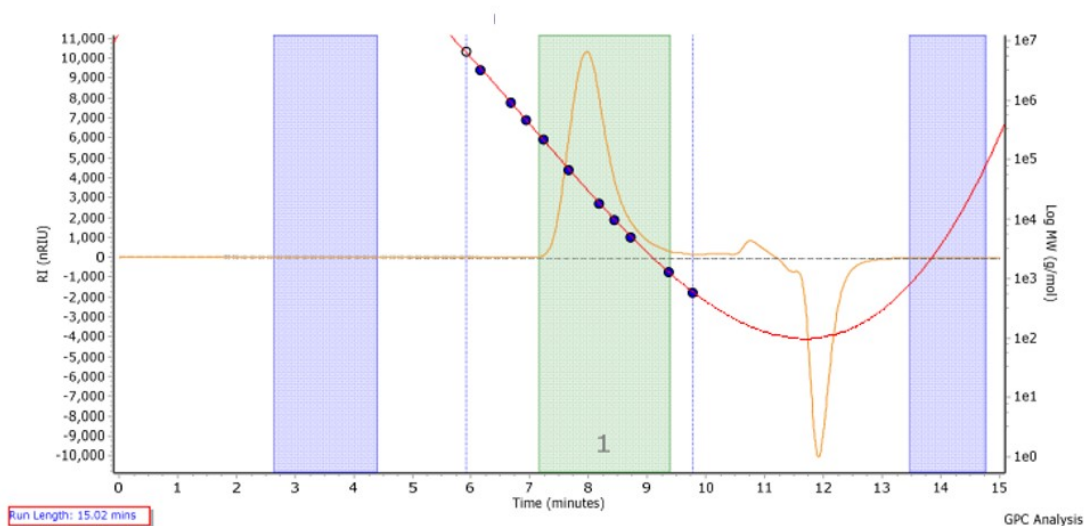


#### Molecular Weight Averages

Peak	Mp (g/mol)	Mn (g/mol)	Mw (g/mol)	Mz (g/mol)	Mz+1 (g/mol)	Mv (g/mol)	PD
Peak 1	32114	14718	35962	62715	94559	58553	2.443

Figure S19. SEC analysis of BPA-PC lampshade.

### Chromatogram Plot

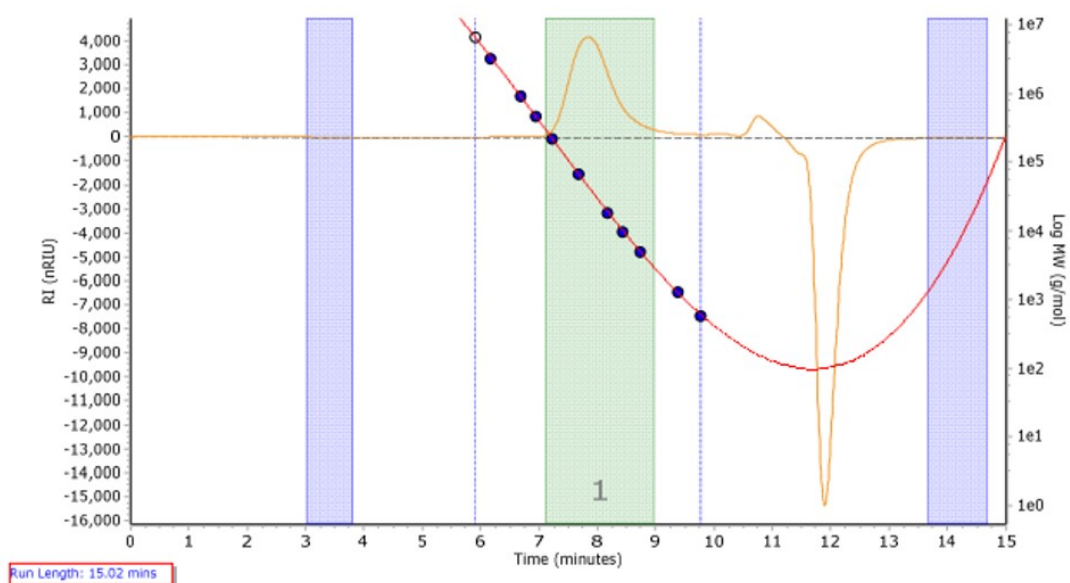


#### Molecular Weight Averages

Peak	Mp (g/mol)	Mn (g/mol)	Mw (g/mol)	Mz (g/mol)	Mz+1 (g/mol)	Mv (g/mol)	PD
Peak 1	31443	14596	34166	57066	81324	53711	2.341

Figure S20. SEC analysis of BPA-PC disk.

### Chromatogram Plot

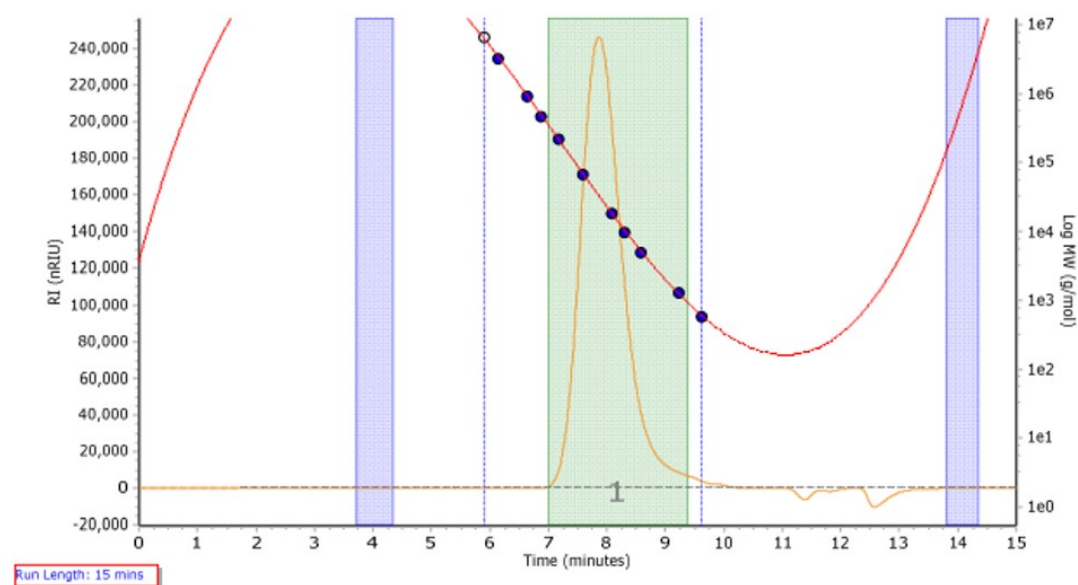


#### Molecular Weight Averages

Peak	Mp (g/mol)	Mn (g/mol)	Mw (g/mol)	Mz (g/mol)	Mz+1 (g/mol)	Mv (g/mol)	PD
Peak 1	44148	22071	48204	81447	115656	76589	2.184

Figure S21. SEC analysis of BPA-PC tube.

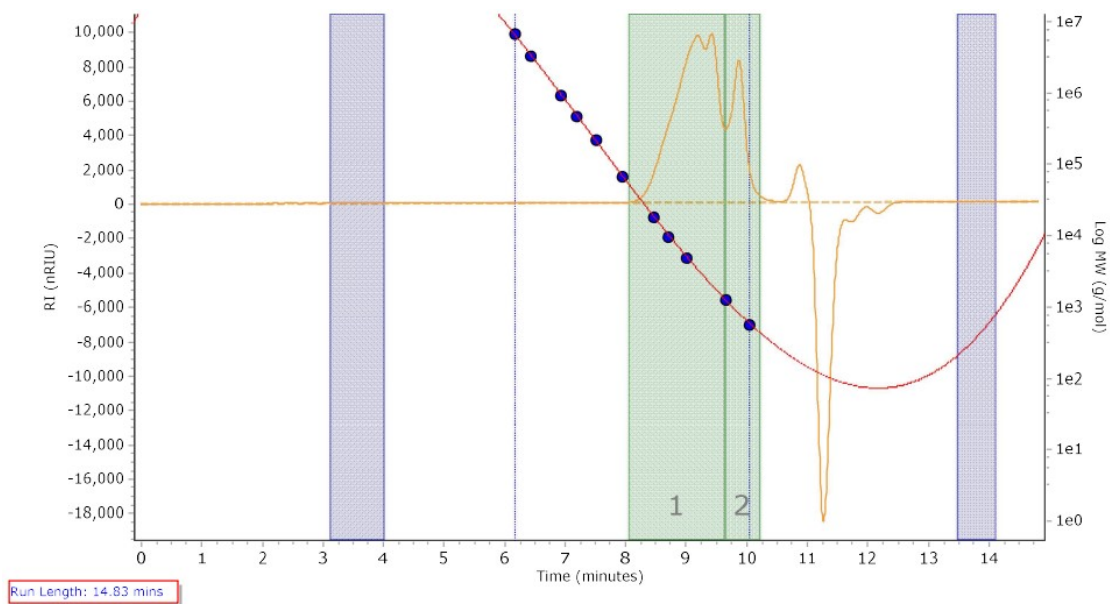
### Chromatogram Plot



#### Molecular Weight Averages

Peak	Mp (g/mol)	Mn (g/mol)	Mw (g/mol)	Mz (g/mol)	Mz+1 (g/mol)	Mv (g/mol)	PD
Peak 1	32297	14114	37441	69105	107801	64081	2.653

Figure S22. SEC analysis of BPA-PC goggle.



**Molecular Weight Averages**

Peak	Mp (g/mol)	Mn (g/mol)	Mw (g/mol)	Mz (g/mol)	Mz+1 (g/mol)	Mv (g/mol)
Peak 1	1994	3219	5241	9320	15081	4809
Peak 2	816	818	857	896	932	852
PD						
	1.628					
	1.048					

Figure S23. SEC analysis of depolymerized product phenoxy resin of DPC-PC-based epoxy thermoset.