processes

MDPI

Supplementary Materials

Chemical Recycling of Used Printed Circuit Board Scraps: Recovery and Utilization of Organic Products

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† Contributed equally to this work

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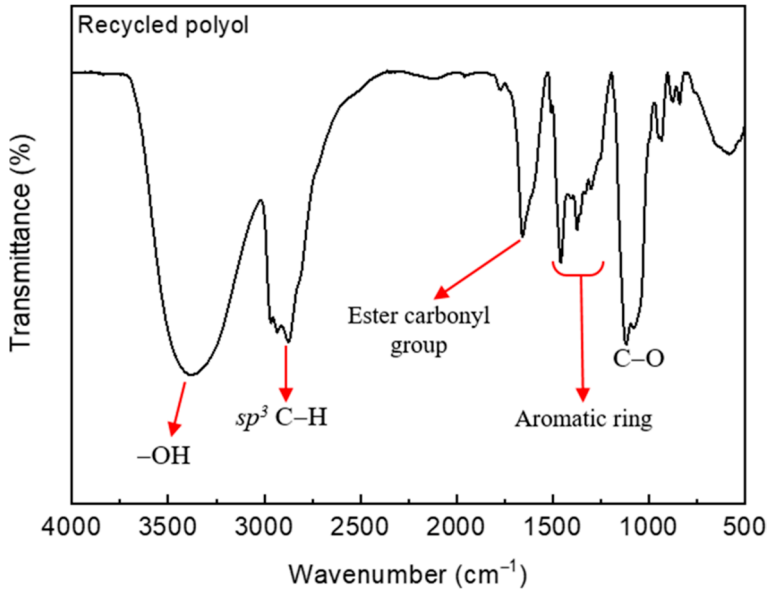


Figure S1. FTIR spectrum of recycled polyol obtained by modification of glycolysis product of UPCBs.

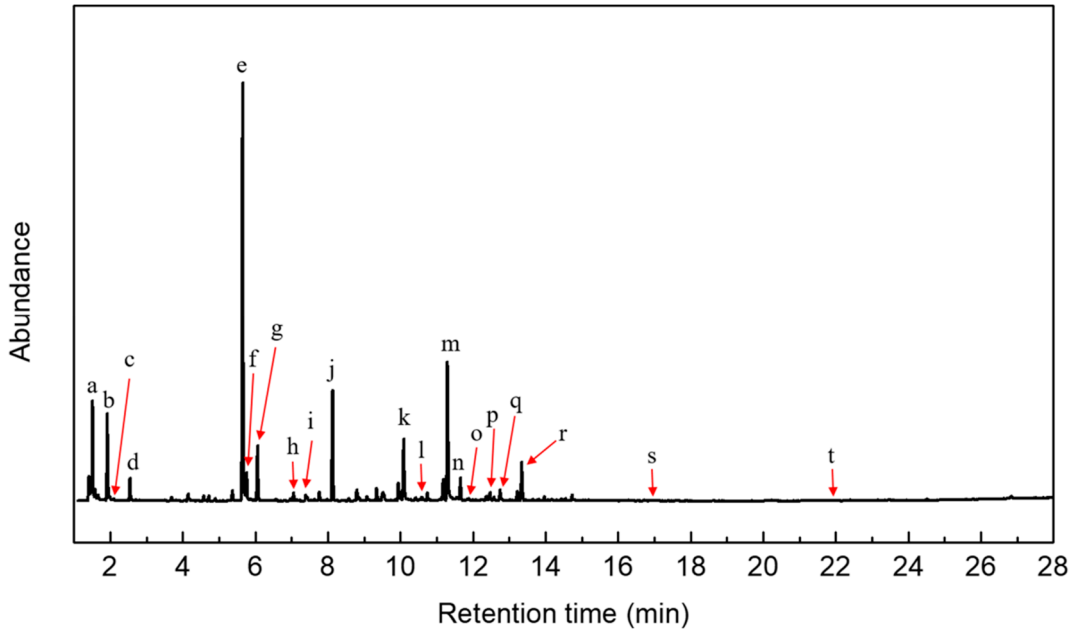
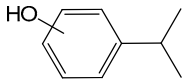
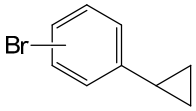
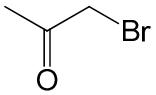
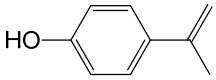
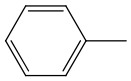
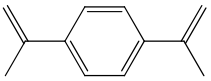
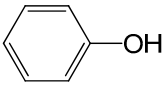
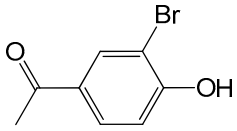
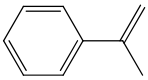
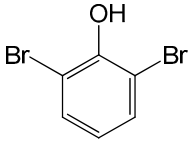
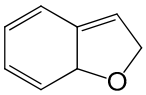
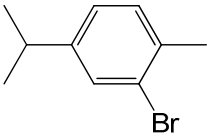
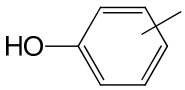
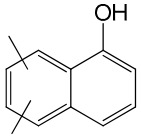
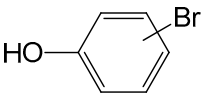
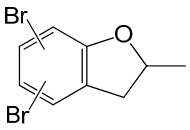
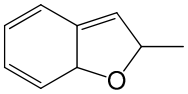
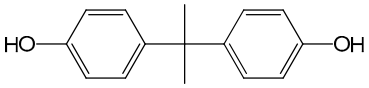


Figure S2. Py-GC/MS of conventional brominated epoxy resin of tetrabromobisphenol A.

Table S1. Representative chemical structure of standard brominated epoxy resin from Py–GC/MS

	Chemical structure		Chemical structure
a		k	
b		l	
c		m	
d		n	
e		o	
f		p	
g		q	
h		r	
i		s	
j		t	

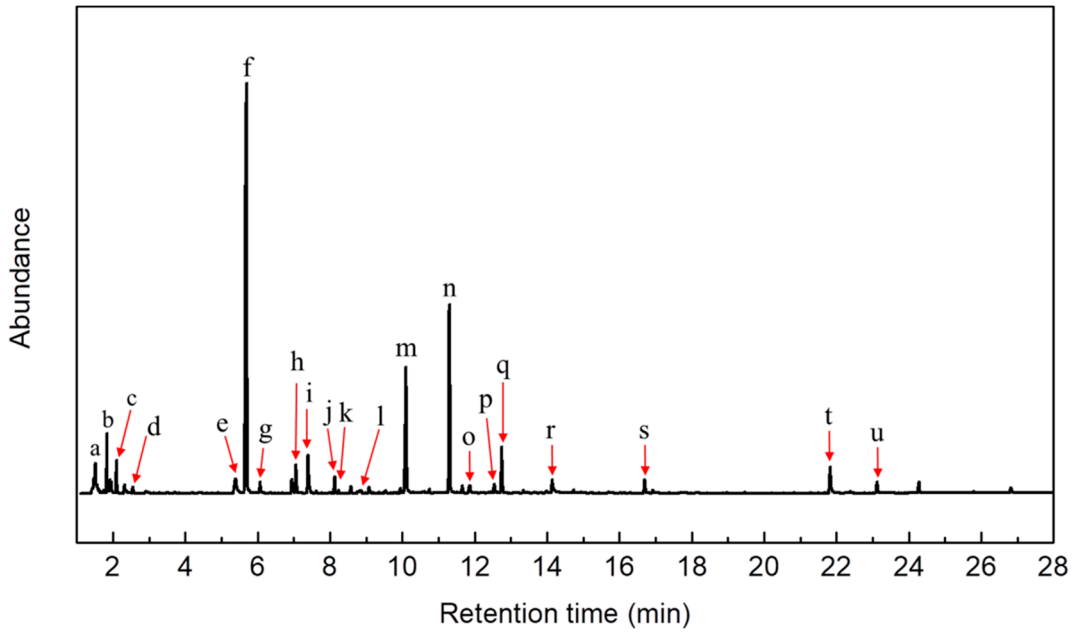
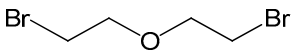
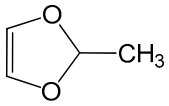
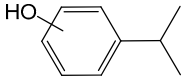
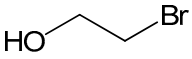
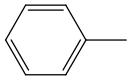
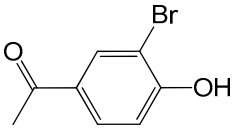
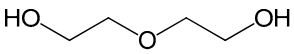
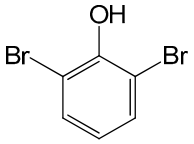
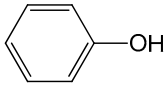
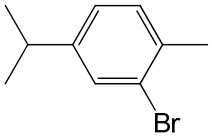
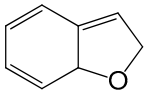
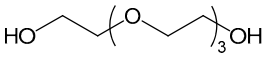
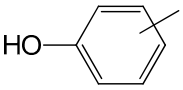
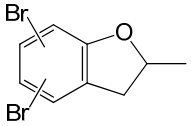
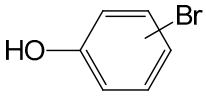
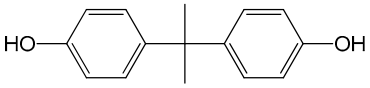
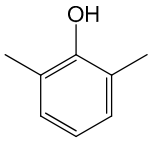
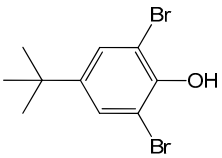
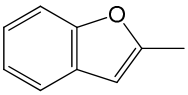


Figure S3. Py-GC/MS of glycolysis product obtained from chemical recycling of UPCBs.

Table S2. Representative chemical structure of glycolysis product by from Py–GC/MS

	Chemical structure		Chemical structure
a		l	
b		m	
c		n	
d		o	
e		p	
f		q	
g		r	
h		s	
i		t	
j		u	
k			

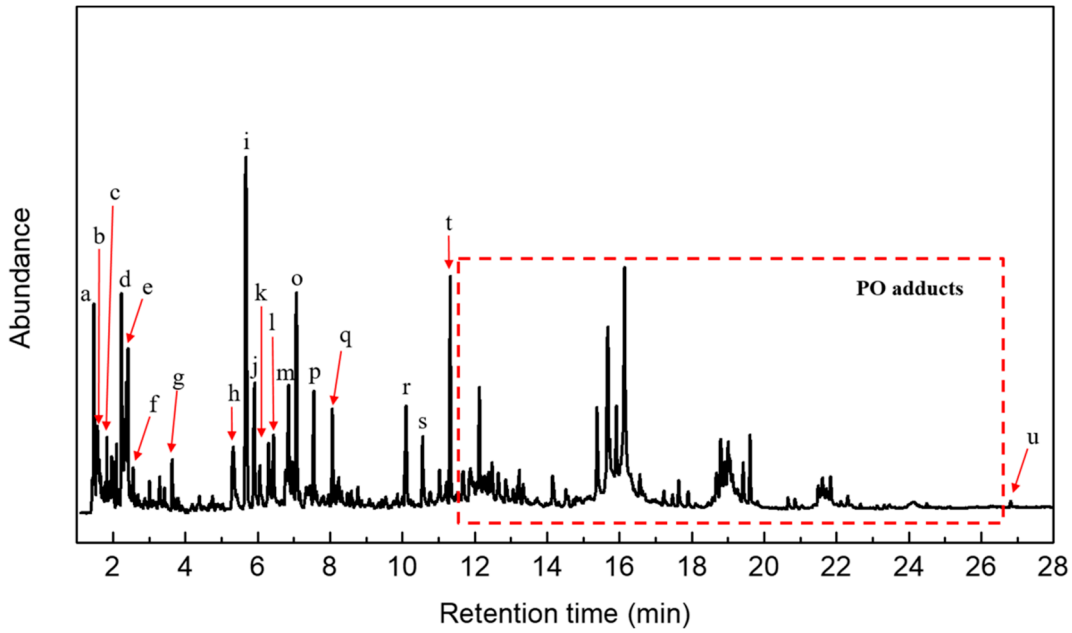


Figure S4. Py-GC/MS of recycled polyol obtained from modification of glycolysis product.

Table S3. Representative chemical structure of recycled polyol from Py–GC/MS

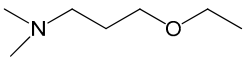
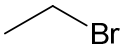
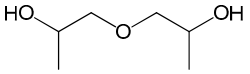
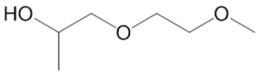
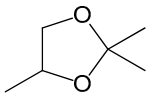
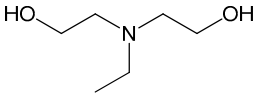
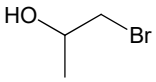
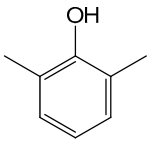
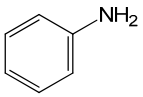
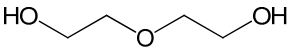
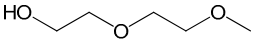
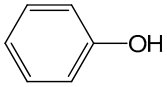
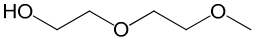
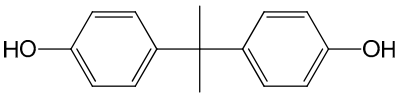
	Chemical structure		Chemical structure
a	CH_3Br	k	
b		l	
c		m	
d		n	
e		o	
f		p	
g		q	
h		r	
i		s	
j		t	

Table S4. Representative brominated compounds in conventional brominated epoxy resin by using Py–GC/MS/ECD

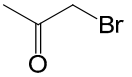
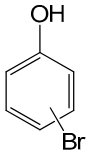
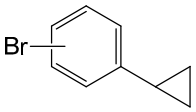
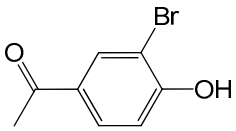
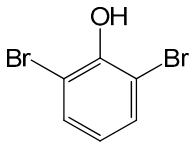
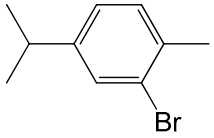
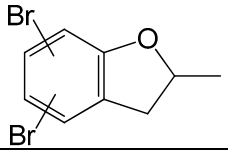
Retention time (min)	Name	Chemical structure
2.49	Bromoacetone	
7.40	Bromophenol	
10.68	Bromocyclopropylbenzene	
11.87	1-(3-bromo-4-hydroxyphenyl)ethanone	
12.54	Dibromophenol	
12.75	2-bromo-4-isopropyl-1-methylbenzene	
16.70	Dibromo-2-methyl-2,3-dihydrobenzofuran	

Table S5. Representative brominated compounds in glycolysis product by using Py–GC/MS/ECD

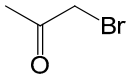
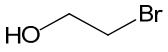
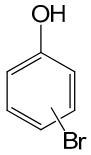
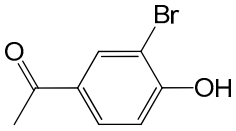
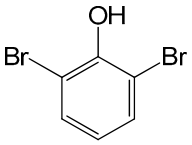
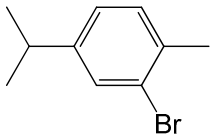
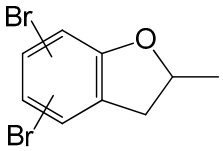
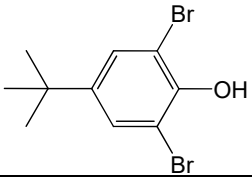
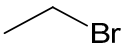
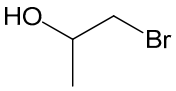
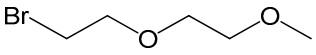
Retention time (min)	Name	Chemical structure
1.48	Bromoacetone	
2.32	Bromoethanol	
7.40	Bromophenol	
11.87	1-(3-bromo-4-hydroxyphenyl)ethanone	
12.54	Dibromophenol	
12.75	2-bromo-4-isopropyl-1-methylbenzene	
16.70	Dibromo-2-methyl-2,3-dihydrobenzofuran	
23.13	2,6-dibromo-4-(tert-butyl)phenol	

Table S6. Representative brominated compounds in recycled polyol by using Py–GC/MS/ECD

Retention time (min)	Name	Chemical structure
1.48	Bromomethane	
1.57	Bromoethane	
2.57	1-bromopropan-2-ol	
7.56	1-bromo-2-(2-methoxyethoxy)ethane	

In GC-MS analyses of recycled polyol, the brominated compounds with very low concentration were hardly detected because the bromine content of recycled polyol was low and the concentration of PO adducts was significantly increased.