SUPPORTING MATERIAL

Recycling of multilayer flexible packaging waste through delamination with recoverable Switchable Hydrophilicity Solvents

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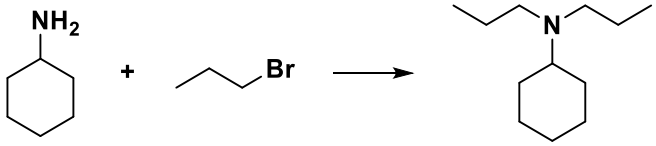
Figure S1. General procedure for the synthesis of *N,N*-dipropylcyclohexylamine and characterization.



In a two-necked round bottom flask under nitrogen atmosphere and flame dried, cyclohexylamine (15 mmol, 1eq), acetonitrile (50 ml) and K_2CO_3 (45 mmol, 3 eq) were added and stirred at room temperature for 15 minutes. Then propylbromide (45 mmol, 3 eq) was added dropwise and the solution was refluxed at 70°C overnight. The reaction was monitored through GC-MS analysis. After the completion, the reaction was quenched with water and extracted three times with a 9:1 CH_2Cl_2/MeOH mixture; the organic layers were combined and then washed with brine, filtered and concentrated under reduced pressure to afford *N,N*-dipropylcyclohexylamine as a light yellow liquid (76% yield, 7.6 mmol, 1.g).

GC-MS*: t_r = 10.70 min, m/z = 183 (M+); 154; 140; 72.

^{1}H NMR (400 MHz, $CDCl_3$): δ 2.42 (tt, J = 10.1, 3.9 Hz, 1H), 2.07 – 1.05 (m, 24H).

* GC-MS spectra were recorded by EI ionization at 70 eV on a Hewlett-Packard 5971 with GC injection on a Zebron ZB-5MS column (30 m L x 0.25 mm ID x 0.25 μm).

Table S1. Classification and features of the three waste categories treated.

Sample	Use	Composition
Group 1	snacks, biscuits, chips, dried fruits	Al < 4% (powder) PP~98%
Group 2	food, animal feed, coffee bags	13<Al<20% (foil) PE (internal layer) PET (external layer) Polyurethane and polyacrylate (tie layer)
Group 3	food, animal feed	1<Al<20% (powder or foil) PE (internal layer) PET (external layer) Polyurethane and polyacrylate (tie layer)

Table S2. Delamination of sample **B** with DMCHA varying the sample loading.

Sample loading (wt%)	Delamination	Total time (h)	Additive solubilisation
1	Yes	2.5	Yes
1.5	Yes	2.5	Yes
2	Yes	2.5	Yes
3	Yes	2.5	Yes
4	Yes	3	No
5	Yes	3	No

Figure S1. Chemical structures of the Switchable Solvents before and after CO_2 addition.

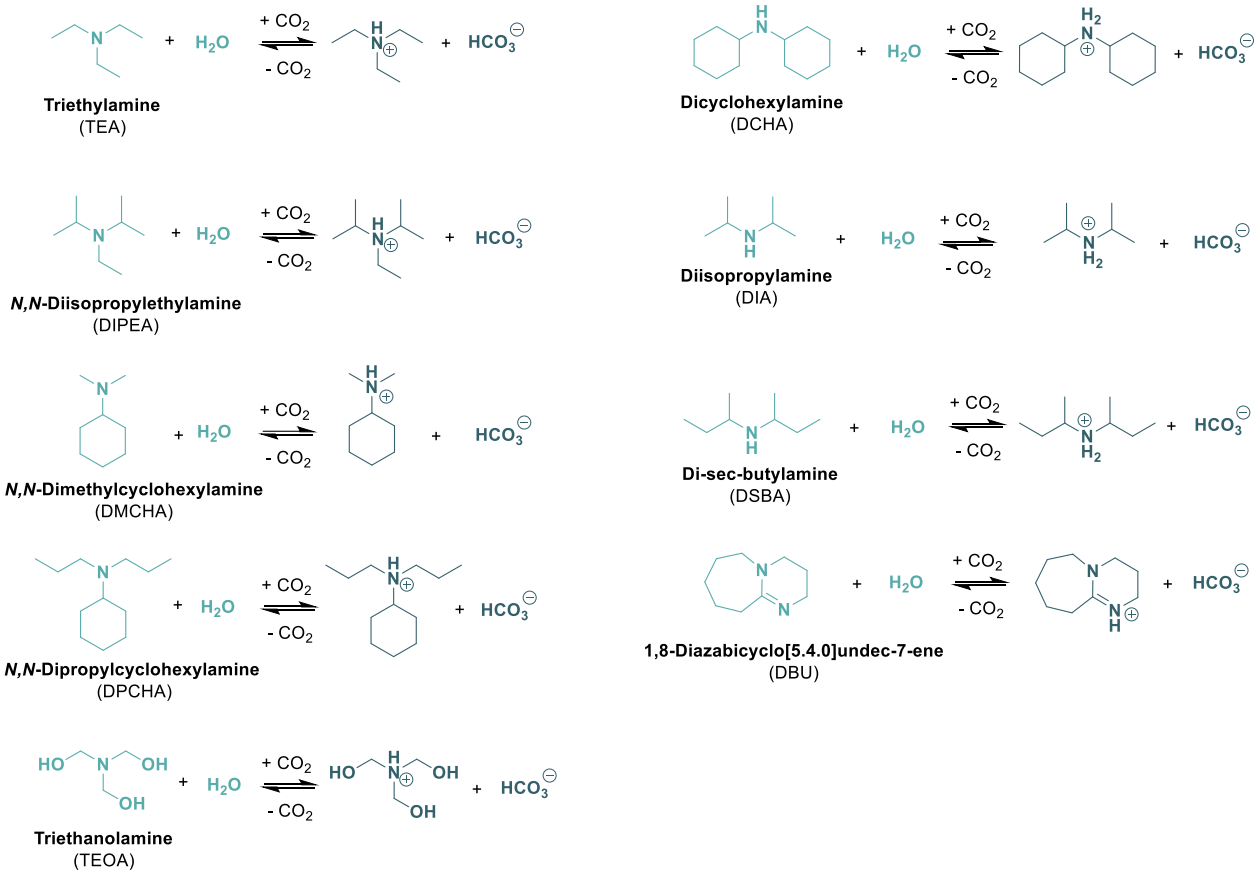


Table S3. Delamination of sample **B** with recycled DMCHA.

Cycle	Delamination	Total time (h)	Additive solubilisation
0	Yes	2.5	Yes
1	Yes	2.5	Yes
2	Yes	2.5	Yes
3	Yes	2.5	Yes
4	Yes	2.5	Yes
5	Yes	2.5	Yes
6	Yes	2.5	Yes
7	Yes	2.5	Yes

Figure S3. DSC curves of the recovered polymers and the corresponding references. (**a**) PE; (**b**) PET; (**c**) PP.

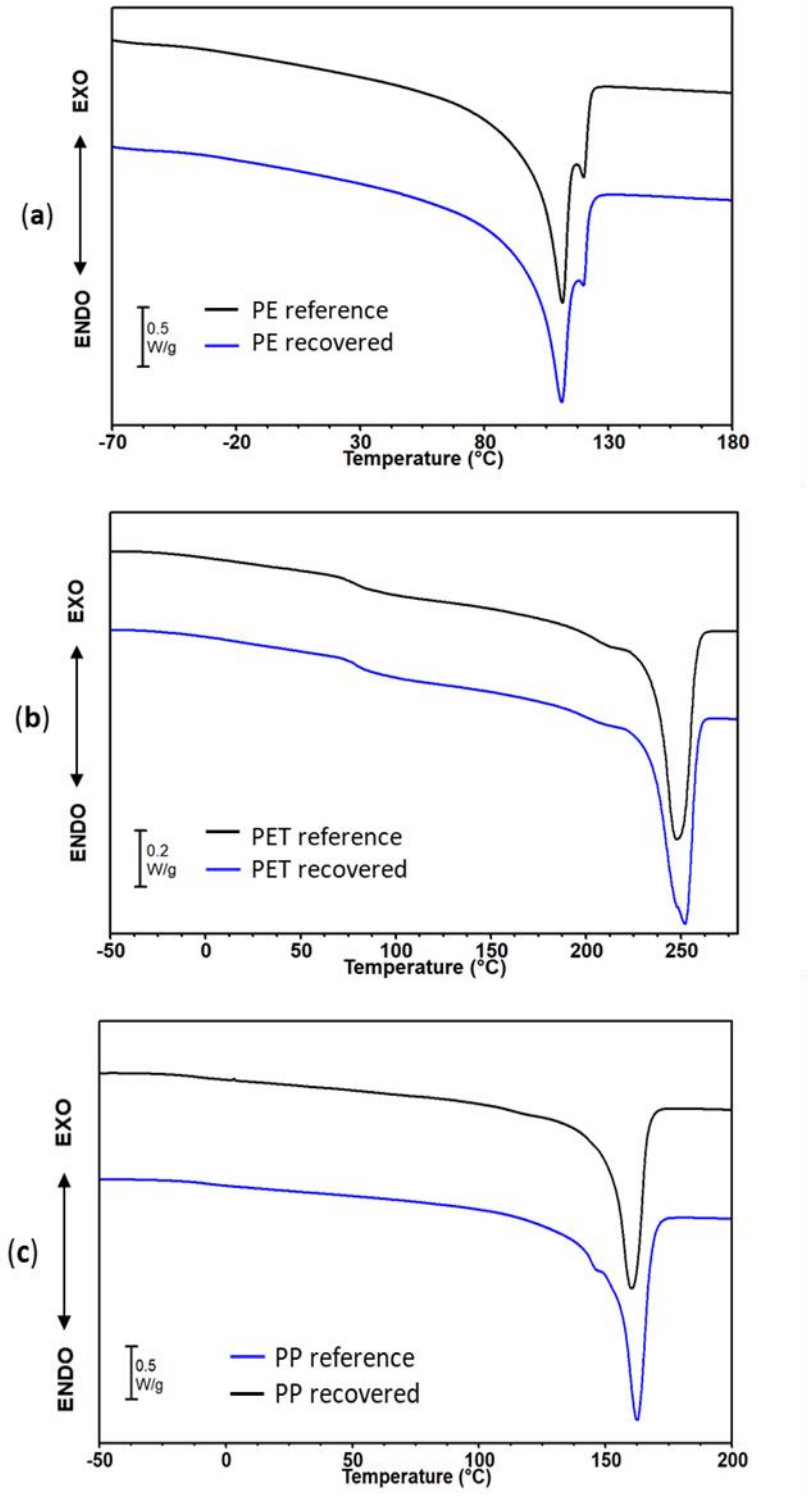


Figure S4. TGA curves of the recovered polymers and the corresponding references. (**a**) PE; (**b**) PET; (**c**) PP.

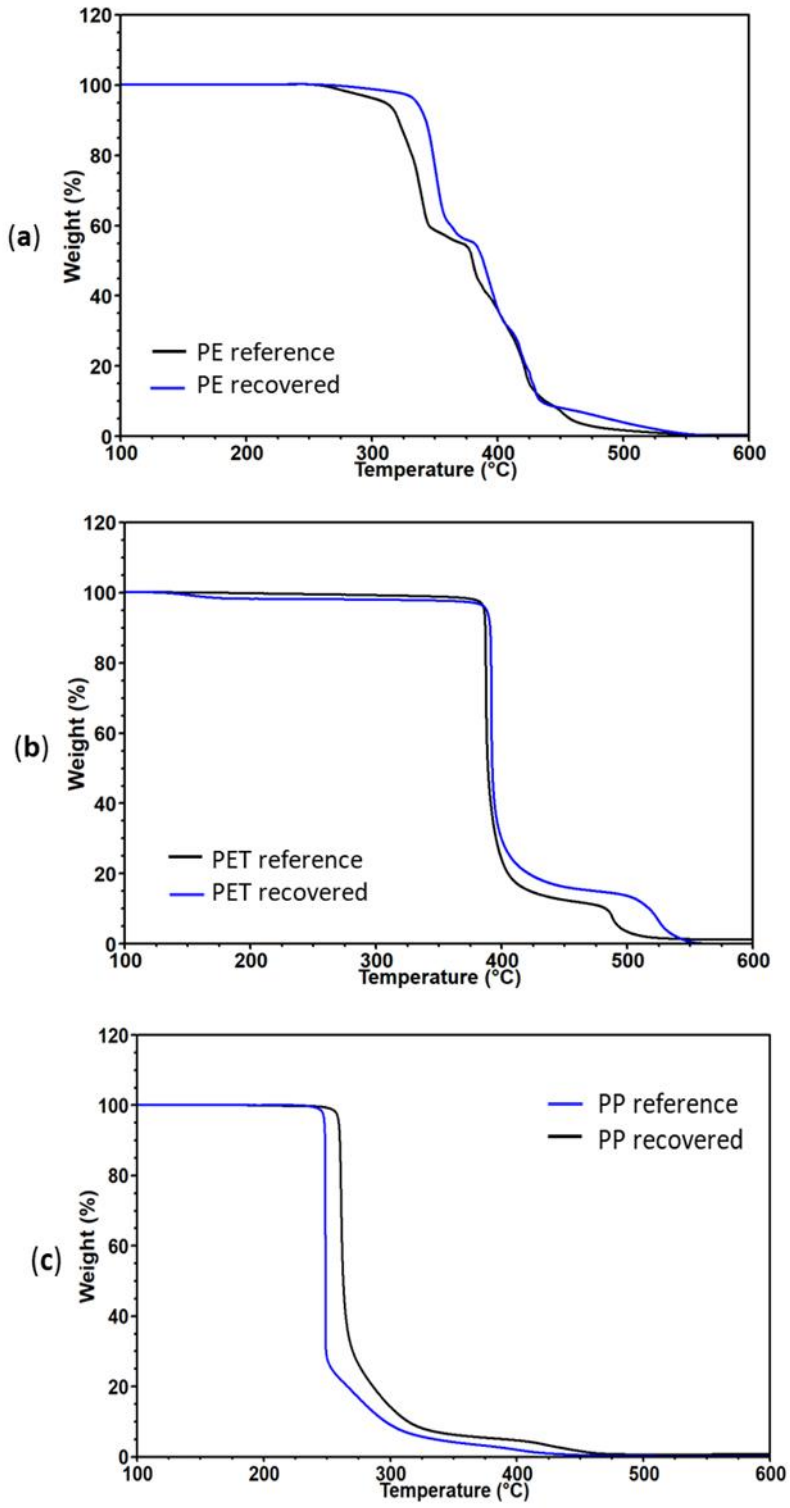
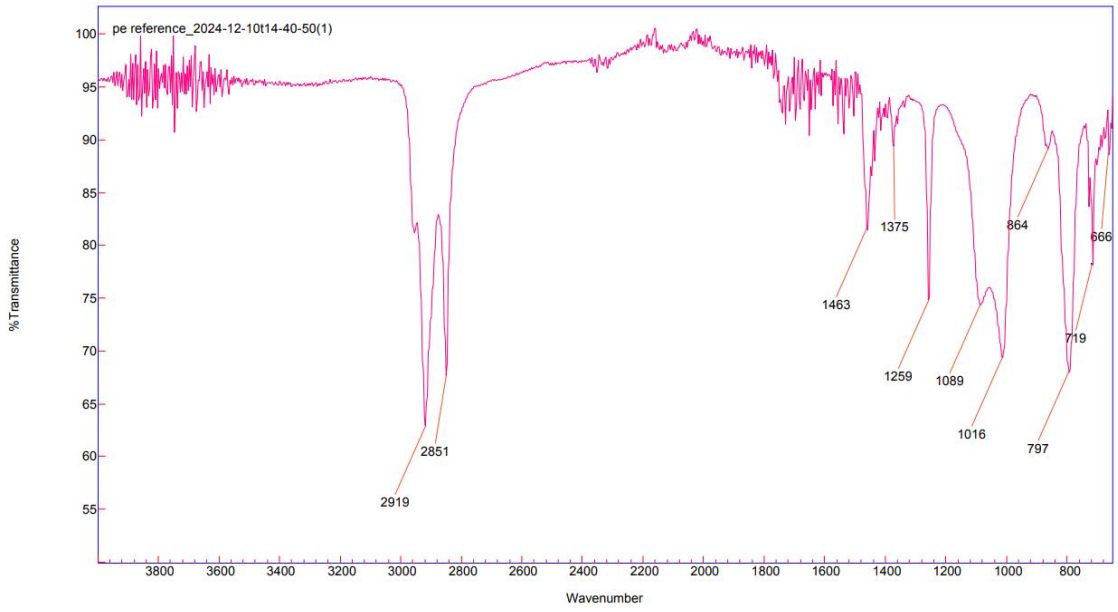
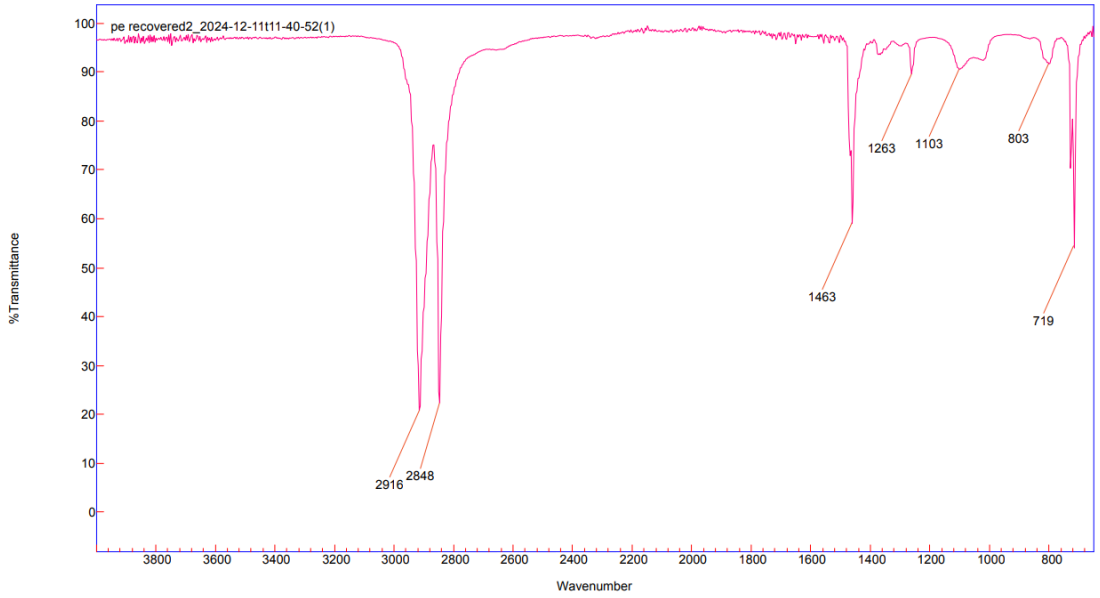


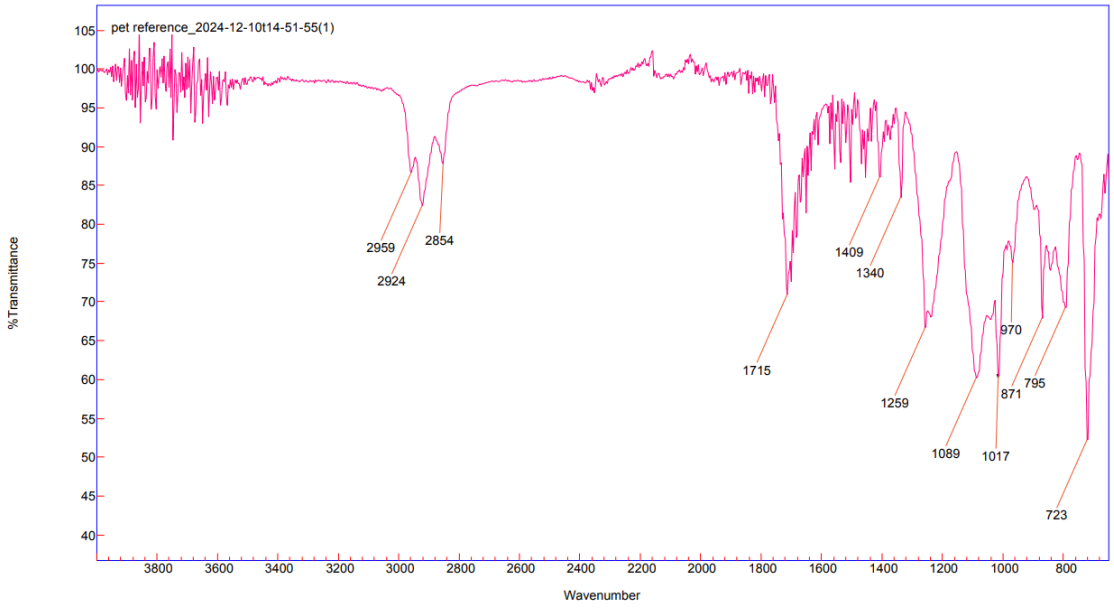
Figure S5. FTIR spectra of the recovered polymeric layers and the corresponding references. (**a**) PE reference; (**b**) PE recovered; (**c**) PET reference; (**d**) PET recovered; (**e**) PP reference; (**f**) PP recovered.



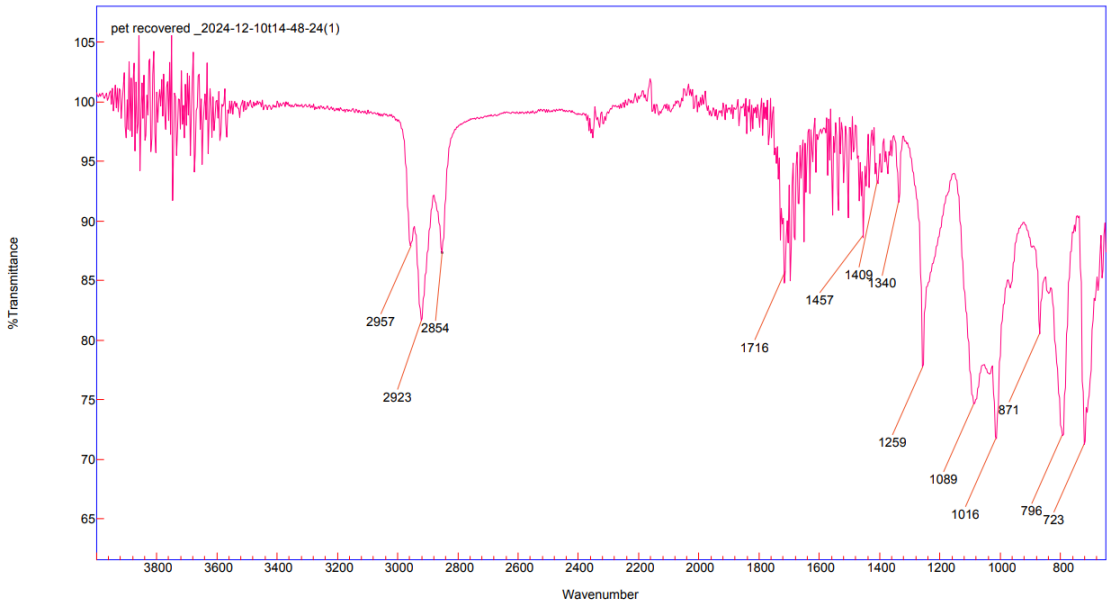
(**a**)



(**b**)


pet reference_2024-12-10t14-51-55(1)
%Transmittance
Wavenumber
2959
2924
2854
1715
1409
1340
1259
970
871
795
1089
1017
723

(**c**)


pet recovered _2024-12-10t14-48-24(1)
%Transmittance
Wavenumber
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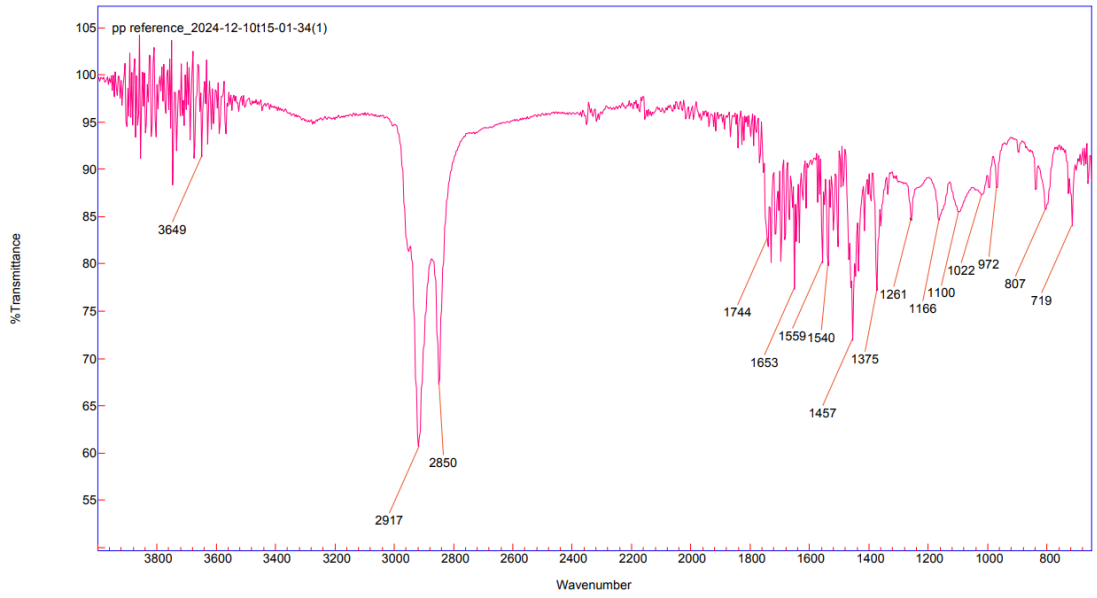
2923
2854
1716
1457
1409
1340
1259
1089
1016
871
796
723

(**d**)


pp reference_2024-12-10t15-01-34(1)
%Transmittance
Wavenumber
3649
2917
2850
1744
1653
1559
1540
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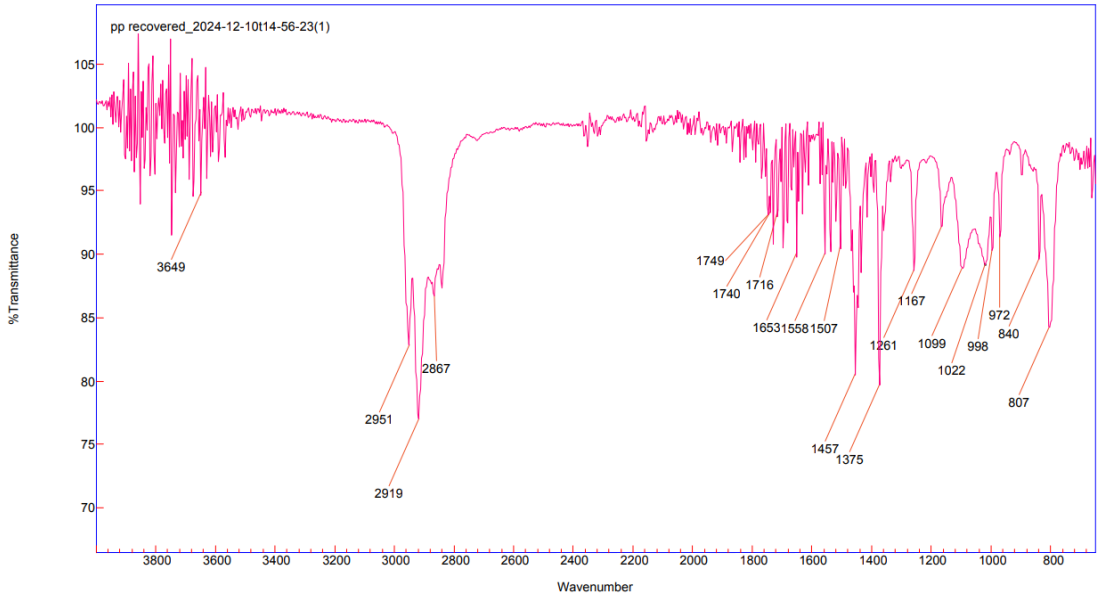
1166
1100
1022
972
807
719

(**e**)


pp recovered_2024-12-10t14-56-23(1)
%Transmittance
Wavenumber
3649
2951
2919
2867
1749
1740
1716
1653
1558
1507
1457
1375
1261
1167
1099
1022
998
972
840
807

(**f**)

Figure S6. ^{1}H NMR spectrum of recovered DMCHA after the switch and back-switch procedure.

