

Supplementary data

^1H NMR spectra of ammonium-based protic ionic liquids (APILs)

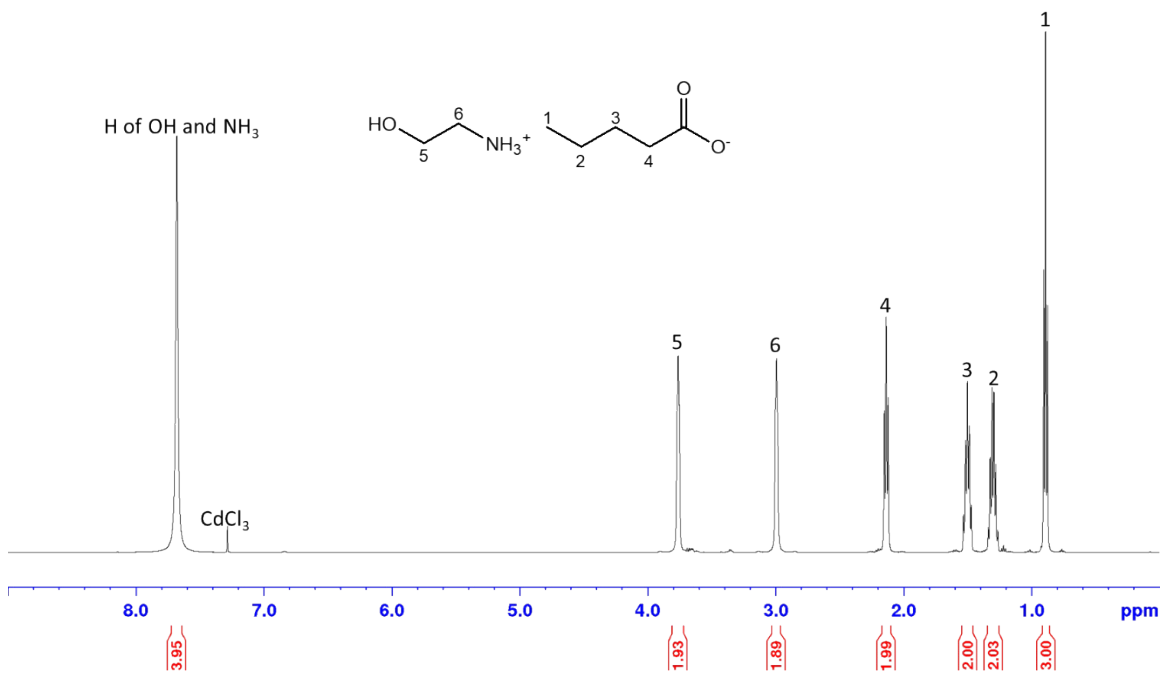


Figure S.1. ^1H NMR spectrum [EtOHA][C5]

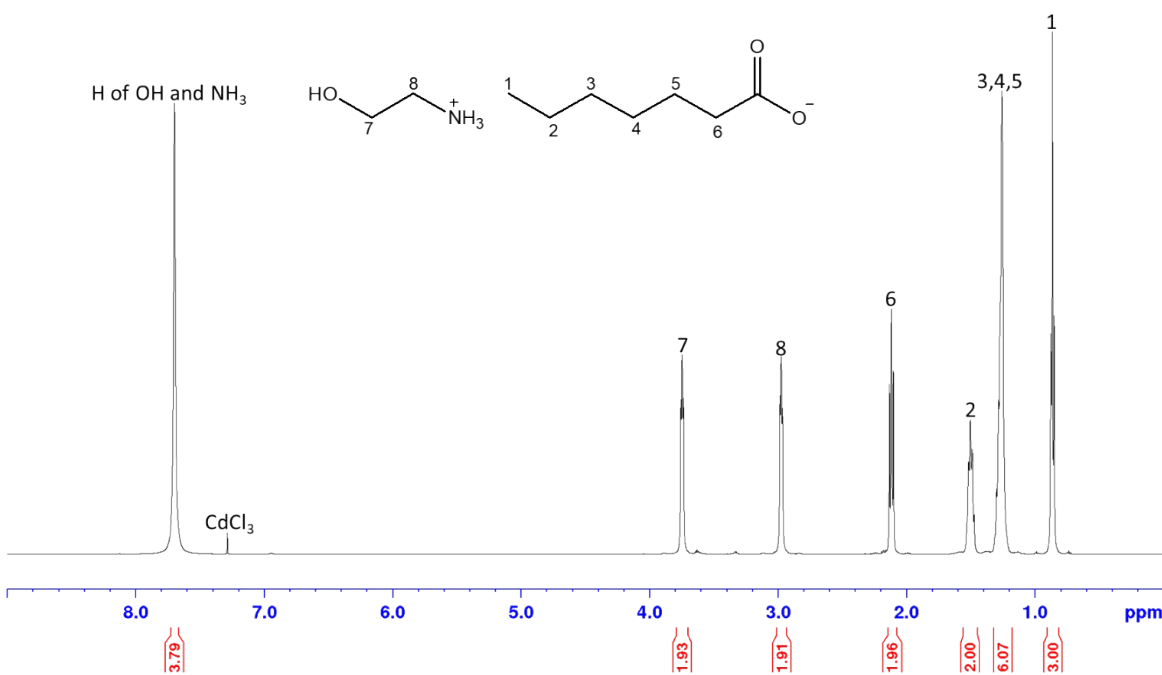


Figure S.2. ^1H NMR spectrum [EtOHA][C7]

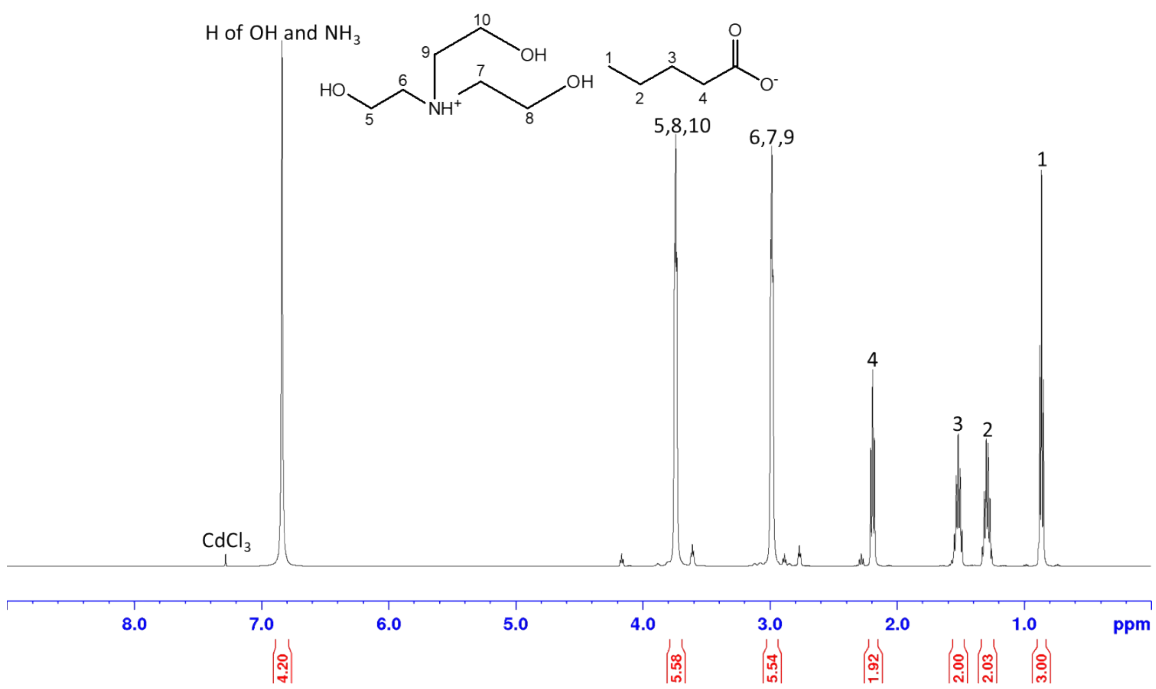


Figure S.3. ¹H NMR spectrum [TRIEOHA][C5]

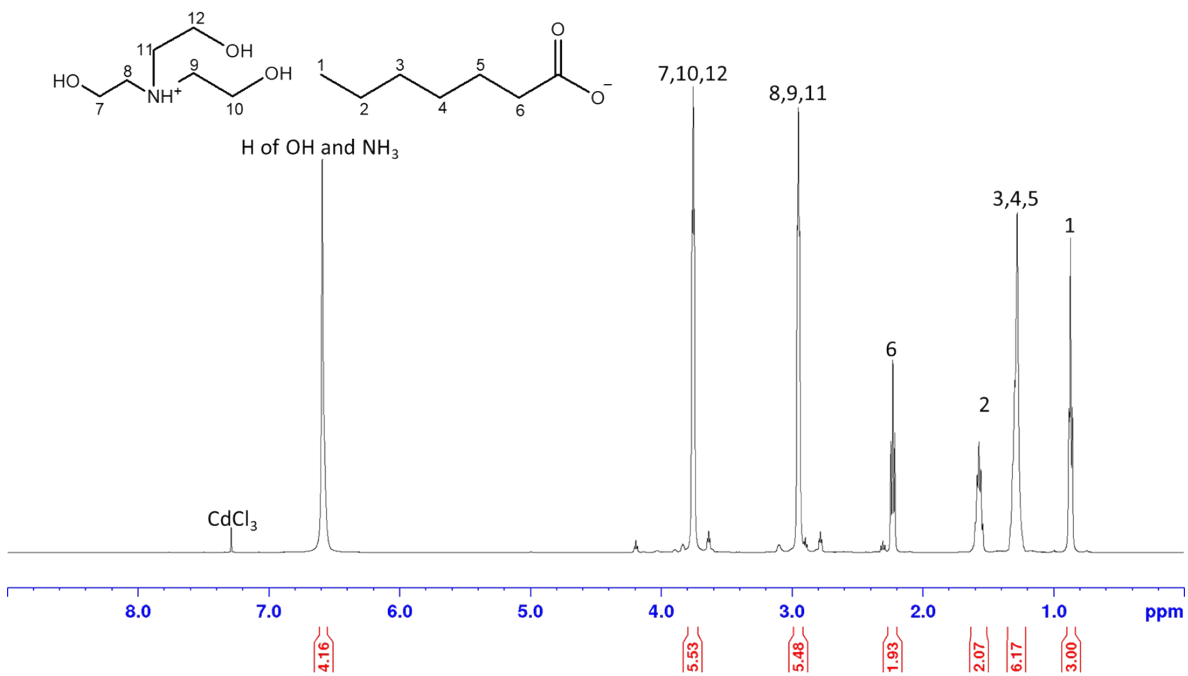


Figure S.4. ¹H NMR spectrum [TRIEOHA][C7]



Figure S.5. ^1H NMR spectrum [TBA][C5]

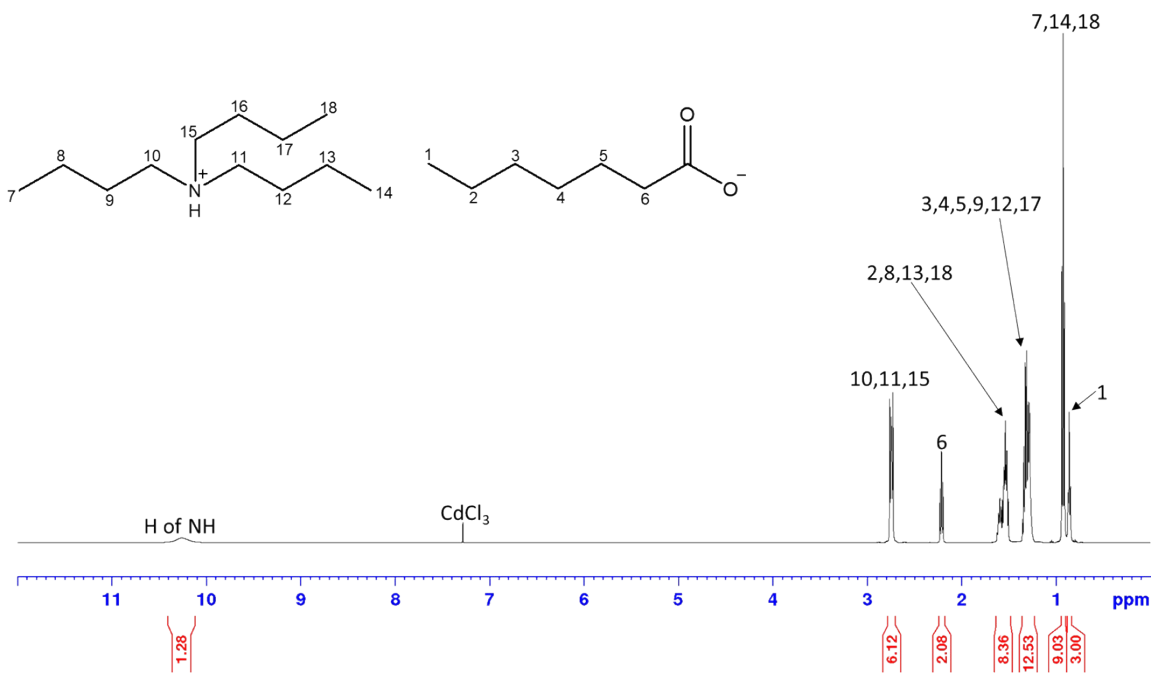


Figure S.6. ^1H NMR spectrum [TBA][C7]

Table S1. Density of APIs at 293.15 -333.15 K

Temperature (K)	Density (gcm ⁻³)					
	[ETOHA][C5]	[ETOHA][C7]	[TRietoHA][C5]	[TRietoHA][C7]	[TBA][C5]	[TBA][C7]
293.15	1.0380	1.0063	1.0920	1.0544	0.8607	0.8434
296.15	1.0364	1.0040	1.0896	1.0528	0.8582	0.8399
298.15	1.0346	1.0024	1.0871	1.0509	0.8564	0.8389
300.15	1.0330	1.0003	1.0851	1.0497	0.8554	0.8379
303.15	1.0314	0.9986	1.0836	1.0486	0.8544	0.8362
306.15	1.0295	0.9972	1.0818	1.0470	0.8530	0.8343
308.15	1.0278	0.9959	1.0789	1.0451	0.8517	0.8328
313.15	1.0256	0.9938	1.0754	1.0419	0.8488	0.8295
323.15	1.0191	0.9876	1.0678	1.0383	0.8418	0.8232
333.15	1.0137	0.9824	1.0624	1.0289	0.8345	0.8156

Table S2. Refractive index of APIs at 293.15 -333.15 K

Temperature (K)	Refractive index					
	[ETOHA][C5]	[ETOHA][C7]	[TRietoHA][C5]	[TRietoHA][C7]	[TBA][C5]	[TBA][C7]
293.15	1.4632	1.4566	1.4739	1.4722	1.4371	1.4394
296.15	1.4625	1.4558	1.4731	1.4715	1.4358	1.4382
298.15	1.4620	1.4552	1.4725	1.4709	1.4350	1.4374
300.15	1.4614	1.4546	1.4718	1.4702	1.4341	1.4365
303.15	1.4606	1.4538	1.4709	1.4692	1.4329	1.4353
306.15	1.4597	1.4528	1.4698	1.4681	1.4316	1.4340
308.15	1.4592	1.4522	1.4691	1.4675	1.4307	1.4332
313.15	1.4577	1.4508	1.4674	1.4657	1.4286	1.4310
323.15	1.4549	1.4477	1.4640	1.4622	1.4244	1.4267
333.15	1.4519	1.4445	1.4605	1.4585	1.4199	1.4226

Table S3. Dynamic viscosity of APIs at 293.15 -333.15 K

Temperature (K)	Dynamic viscosity (mPa.s)					
	[ETOHA][C5]	[ETOHA][C7]	[TRietoHA][C5]	[TRietoHA][C7]	[TBA][C5]	[TBA][C7]
293.15	1379.63	279.40	804.79	848.81	10.03	11.52
298.15	991.30	208.67	585.92	596.88	8.01	9.32
303.15	745.70	152.46	405.27	417.34	6.73	7.80
308.15	539.76	123.16	276.19	299.94	5.63	6.53
313.15	391.78	90.77	197.86	213.59	5.03	5.52
323.15	222.51	62.39	112.12	122.52	3.68	4.14
333.15	134.15	42.57	65.87	72.02	2.92	3.29

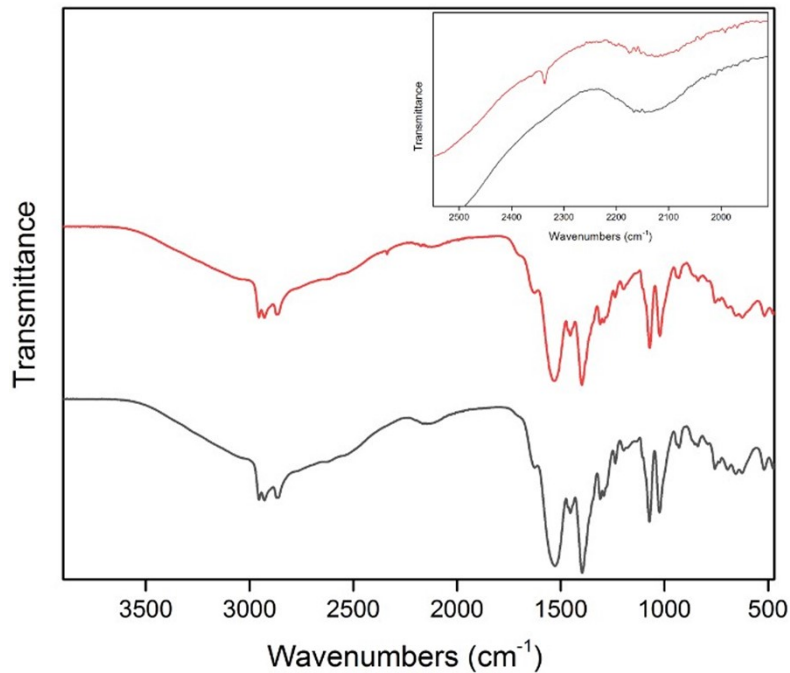


Figure S.7. FTIR spectra of [ETOHA][C5], before and after CO₂ absorption. (-) Black and (-) red denote before and after absorption, respectively. Inset figure shows the wavenumbers in the region approximately 2300 cm⁻¹ to highlight the presence of CO₂ in [ETOHA][C5]

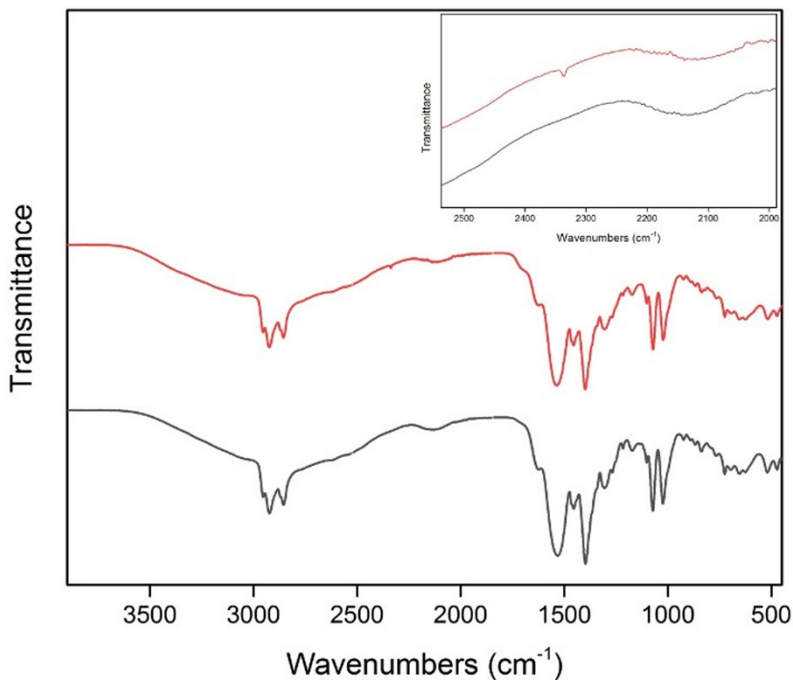


Figure S.8. FTIR spectra of [ETOHA][C7], before and after CO₂ absorption. (-) Black and (-) red denote before and after absorption, respectively. Inset figure shows the wavenumbers in the region approximately 2300 cm⁻¹ to highlight the presence of CO₂ in [ETOHA][C7]

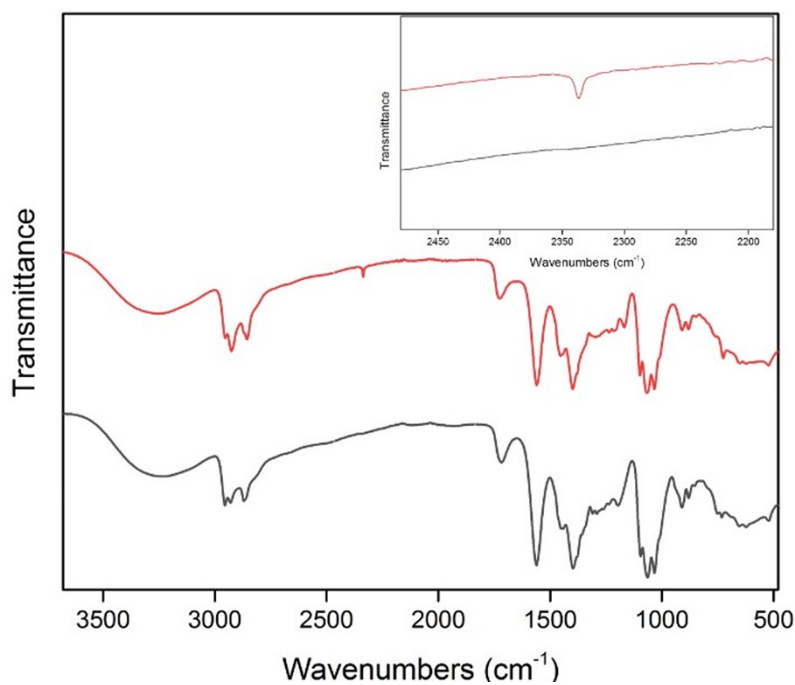


Figure S.9. FTIR spectra of [TRietoHA][C5], before and after CO₂ absorption. (-) Black and (-) red denote before and after absorption, respectively. Inset figure shows the wavenumbers in the region approximately 2300 cm⁻¹ to highlight the presence of CO₂ in [TRietoHA][C5]

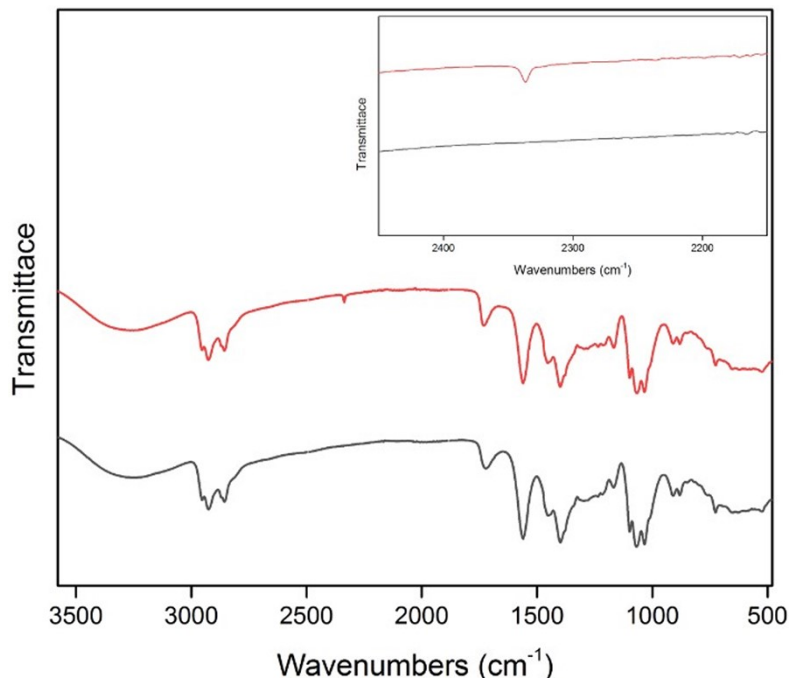


Figure S.10. FTIR spectra of [TRietoHA][C7], before and after CO₂ absorption. (-) Black and (-) red denote before and after absorption, respectively. Inset figure shows the wavenumbers in the region approximately 2300 cm⁻¹ to highlight the presence of CO₂ in [TRietoHA][C7]

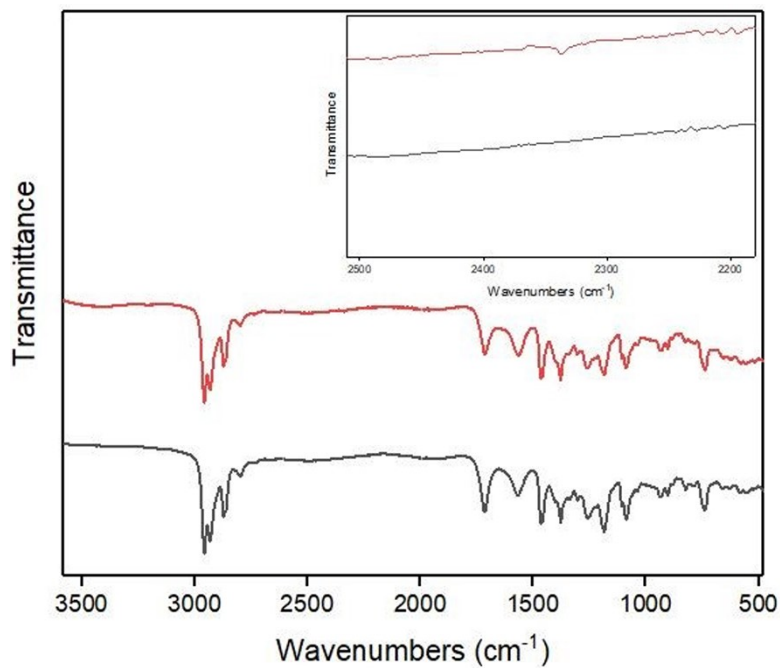


Figure S.11. FTIR spectra of [TBA][C5], before and after CO₂ absorption. (-) Black and (-) red denote before and after absorption, respectively. Inset figure shows the wavenumbers in the region approximately 2300 cm⁻¹ to highlight the presence of CO₂ in [TBA][C5]