

Electronic Supplementary Information for

The adsorption characteristics and mechanism of montmorillonite with different layer charge density for alkyl ammonium with different carbon chain length

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Table S1. Chemical composition of two kinds of Ca-MT (wt%).

Type	SiO ₂	Al ₂ O ₃	MgO	Na ₂ O	Fe ₂ O ₃	K ₂ O	CaO	TiO ₂
Ca-MT1	68.65	16.04	4.15	1.99	2.98	2.86	3.33	0
Ca-MT2	66.83	18.79	6.44	0.34	2.80	0.41	3.98	0.41

Table S2. Changes in the adsorbance of Na-MT1 for DTAC at different exchange time.

Time, min		0	0.5	1	3	5	15	30
0.7 CEC	Concentration mmol/L	7.875	1.363	0.563	0.250	0.200	0.213	0.200
	Adsorbance mmol/g	0.000	0.521	0.585	0.610	0.614	0.613	0.614
1.3 CEC	Concentration mmol/L	14.625	5.425	3.725	2.213	2.000	2.013	2.025
	Adsorbance mmol/g	0.000	0.736	0.872	0.993	1.010	1.009	1.008
3.0 CEC	Concentration mmol/L	33.750	17.413	15.600	14.888	14.738	14.588	14.250
	Adsorbance mmol/g	0.000	1.307	1.452	1.509	1.521	1.533	1.560

Table S3. Changes in the adsorbance of Na-MT1 for TTAC at different exchange time.

Time, min		0	0.5	1	3	5	15	30
0.7 CEC	Concentration mmol/L	7.875	1.113	0.575	0.225	0.225	0.213	0.225
	Adsorbance mmol/g	0.000	0.541	0.584	0.612	0.612	0.613	0.612
1.3 CEC	Concentration mmol/L	14.625	3.975	2.488	2.013	1.850	1.850	1.850
	Adsorbance mmol/g	0.000	0.852	0.971	1.009	1.022	1.022	1.022
3.0 CEC	Concentration mmol/L	33.750	16.650	14.638	14.113	13.713	13.038	13.050
	Adsorbance mmol/g	0.000	1.368	1.529	1.571	1.603	1.657	1.656

Table S4. Changes in the adsorbance of Na-MT1 for CTAC at different exchange time.

Time, min		0	0.5	1	3	5	15	30
0.7 CEC	Concentration mmol/L	7.875	0.775	0.475	0.188	0.188	0.175	0.175
	Adsorbance mmol/g	0.000	0.568	0.592	0.615	0.615	0.616	0.616
1.3 CEC	Concentration mmol/L	14.625	2.950	1.813	0.863	0.800	0.788	0.800
	Adsorbance mmol/g	0.000	0.934	1.025	1.101	1.106	1.107	1.106
3.0 CEC	Concentration mmol/L	33.750	13.350	10.925	10.113	9.538	9.350	9.338
	Adsorbance mmol/g	0.000	1.632	1.826	1.891	1.937	1.952	1.953

Table S5. Changes in the adsorbance of Na-MT1 for OTAC at different exchange time.

Time, min		0	0.5	1	3	5	15	30
0.7 CEC	Concentration mmol/L	7.875	0.363	0.138	0.125	0.125	0.113	0.125
	Adsorbance mmol/g	0.000	0.601	0.619	0.620	0.620	0.621	0.620
1.3 CEC	Concentration mmol/L	14.625	2.325	1.688	0.638	0.613	0.600	0.588
	Adsorbance mmol/g	0.000	0.984	1.035	1.119	1.121	1.122	1.123
3.0 CEC	Concentration mmol/L	33.750	13.013	10.988	8.900	8.725	8.563	8.575
	Adsorbance mmol/g	0.000	1.659	1.821	1.988	2.002	2.015	2.014

Table S6. Changes in the adsorbance of Na-MT2 for DTAC at different exchange time.

Time, min		0	0.5	1	3	5	15	30
0.7 CEC 80°C	Concentration mmol/L	9.538	0.526	0.426	0.176	0.188	0.176	0.176
	Adsorbance mmol/g	0.000	0.721	0.729	0.749	0.748	0.749	0.749
1.3 CEC 80°C	Concentration mmol/L	17.713	3.463	2.013	1.738	1.650	1.663	1.663
	Adsorbance mmol/g	0.000	1.140	1.256	1.278	1.285	1.284	1.284
3.0 CEC 80°C	Concentration mmol/L	40.875	17.388	16.938	16.775	16.475	16.388	16.375
	Adsorbance mmol/g	0.000	1.879	1.915	1.928	1.952	1.959	1.960

Table S7. Changes in the adsorbance of Na-MT2 for TTAC at different exchange time.

Time, min		0	0.5	1	3	5	15	30
0.7 CEC 80°C	Concentration mmol/L	9.538	0.525	0.425	0.175	0.188	0.175	0.175
	Adsorbance mmol/g	0.000	0.721	0.729	0.749	0.748	0.749	0.749
1.3 CEC 80°C	Concentration mmol/L	17.713	3.050	1.850	1.638	1.625	1.638	1.625
	Adsorbance mmol/g	0.000	1.173	1.269	1.286	1.287	1.286	1.287
3.0 CEC 80°C	Concentration mmol/L	40.875	14.525	14.388	14.213	14.063	14.050	14.063
	Adsorbance mmol/g	0.000	2.108	2.119	2.133	2.145	2.146	2.145

Table S8. Changes in the adsorbance of Na-MT2 for CTAC at different exchange time.

Time, min		0	0.5	1	3	5	15	30
0.7 CEC 80°C	Concentration mmol/L	9.538	0.300	0.163	0.175	0.163	0.163	0.175
	Adsorbance mmol/g	0.000	0.739	0.750	0.749	0.750	0.750	0.749
1.3 CEC	Concentration mmol/L	17.713	3.450	1.563	1.463	1.475	1.463	1.463

80°C	Adsorbance mmol/g	0.000	1.141	1.292	1.300	1.299	1.300	1.300
3.0	Concentration mmol/L	40.875	11.825	11.613	11.538	11.488	11.500	11.488
CEC	Adsorbance mmol/g	0.000	2.324	2.341	2.347	2.351	2.350	2.351

Table S9. Changes in the adsorbance of Na-MT2 for OTAC at different exchange time.

Time, min		0	0.5	1	3	5	15	30
0.7	Concentration mmol/L	9.538	0.125	0.125	0.137	0.137	0.137	0.125
CEC	Adsorbance mmol/g	0.000	0.753	0.753	0.752	0.752	0.752	0.753
1.3	Concentration mmol/L	17.713	3.638	1.200	0.975	0.963	0.975	0.963
CEC	Adsorbance mmol/g	0.000	1.126	1.321	1.339	1.340	1.339	1.340
3.0	Concentration mmol/L	40.875	11.550	10.950	10.763	10.623	10.600	10.600
CEC	Adsorbance mmol/g	0.000	2.346	2.394	2.409	2.420	2.422	2.422

Table S10. Quasi-second-order dynamics parameters for the adsorption of Na-MT1 for alkyl ammonium with different carbon chain length.

Type	$Q_e(\text{exp})$ mmol/g				q_e mmol/g				K g/(mmol·min)				R^2			
	DTAC	TTAC	CTAC	OTAC	DTAC	TTAC	CTAC	OTAC	DTAC	TTAC	CTAC	OTAC	DTAC	TTAC	CTAC	OTAC
0.7 CEC	0.614	0.613	0.616	0.620	0.613	0.612	0.615	0.620	91.97	195.11	280.87	332.08	1	1	1	1
1.3 CEC	1.010	1.023	1.107	1.123	1.009	1.023	1.107	1.123	19.70	27.10	27.55	32.33	1	1	1	1
3.0 CEC	1.560	1.657	1.953	2.016	1.560	1.657	1.953	2.015	7.07	7.87	10.41	12.87	1	1	1	1

Table S11. Quasi-second-order dynamics parameters for the adsorption of Na-MT2 for alkyl ammonium with different carbon chain length.

Type	$Q_e(\text{exp})$ mmol/g				q_e mmol/g				K g/(mmol·min)				R^2			
	DTAC	TTAC	CTAC	OTAC	DTAC	TTAC	CTAC	OTAC	DTAC	TTAC	CTAC	OTAC	DTAC	TTAC	CTAC	OTAC
0.7 CEC	0.749	0.752	0.750	0.752	0.749	0.749	0.750	0.753	96.30	319.21	375.27	984.38	1	1	1	1
1.3 CEC	1.285	1.287	1.300	1.340	1.285	1.287	1.300	1.340	37.37	60.76	79.63	114.02	1	1	1	1
3.0 CEC	1.959	2.146	2.351	2.422	1.959	2.146	2.351	2.422	34.86	37.93	39.62	42.21	1	1	1	1

Table S12. Isothermal adsorption of Na-MT1 for DTAC at different temperature.

Amount	Adsorbance, mmol/g					Equilibrium concentration, mmol/L			Adsorption efficiency η , %		
	mmol/g	25°C	50°C	80°C		25°C	50°C	80°C	25°C	50°C	80°C
0.50	0.45	0.447	0.446	0.445		0.011	0.012	0.016	99.27	99.19	98.95
0.70	0.63	0.626	0.625	0.624		0.013	0.018	0.019	99.36	99.14	99.08
1.00	0.90	0.887	0.887	0.886		0.042	0.042	0.048	98.60	98.60	98.40

1.30	1.17	1.045	1.043	1.042	0.117	0.123	0.128	96.75	96.59	96.45
1.50	1.35	1.250	1.247	1.246	0.335	0.342	0.347	92.56	92.40	92.30
1.70	1.53	1.397	1.391	1.387	0.444	0.462	0.475	91.30	90.94	90.68
2.00	1.80	1.495	1.491	1.485	1.017	1.031	1.051	83.06	82.82	82.48
2.30	2.07	1.577	1.552	1.534	1.645	1.728	1.788	76.16	74.95	74.09
2.50	2.25	1.642	1.599	1.535	2.027	2.170	2.384	72.97	71.07	68.21
2.80	2.52	1.640	1.591	1.558	2.934	3.096	3.207	65.07	63.15	61.82
3.00	2.70	1.641	1.593	1.557	3.530	3.689	3.808	60.78	59.01	57.68

Table S13. Isothermal adsorption of Na-MT1 for TTAC at different temperature.

Amount		Adsorbance, mmol/g			Equilibrium concentration, mmol/L			Adsorption efficiency η , %		
CEC	mmol/g	25°C	50°C	80°C	25°C	50°C	80°C	25°C	50°C	80°C
0.50	0.45	0.447	0.446	0.446	0.009	0.012	0.013	99.39	99.22	99.13
0.70	0.63	0.623	0.623	0.622	0.022	0.025	0.026	98.95	98.83	98.77
1.00	0.90	0.891	0.891	0.890	0.031	0.031	0.035	98.97	98.97	98.84
1.30	1.17	1.048	1.043	1.042	0.108	0.122	0.127	97.00	96.61	96.47
1.50	1.35	1.278	1.266	1.263	0.240	0.279	0.291	94.67	93.81	93.53
1.70	1.53	1.428	1.409	1.409	0.340	0.404	0.404	93.33	92.07	92.07
2.00	1.80	1.552	1.536	1.533	0.828	0.879	0.892	86.21	85.35	85.14
2.30	2.07	1.633	1.633	1.629	1.456	1.456	1.469	78.90	78.90	78.71
2.50	2.25	1.705	1.667	1.648	1.815	1.943	2.008	75.80	74.09	73.23
2.80	2.52	1.733	1.687	1.675	2.623	2.777	2.816	68.77	66.94	66.48
3.00	2.70	1.744	1.674	1.663	3.188	3.419	3.457	64.58	62.02	61.59

Table S14. Isothermal adsorption of Na-MT1 for CTAC at different temperature.

Amount		Adsorbance, mmol/g			Equilibrium concentration, mmol/L			Adsorption efficiency η , %		
CEC	mmol/g	25°C	50°C	80°C	25°C	50°C	80°C	25°C	50°C	80°C
0.50	0.45	0.448	0.447	0.447	0.008	0.010	0.011	99.47	99.36	99.25
0.70	0.63	0.626	0.626	0.624	0.013	0.014	0.021	99.39	99.31	99.00
1.00	0.90	0.893	0.893	0.892	0.023	0.024	0.026	99.24	99.19	99.14
1.30	1.17	1.072	1.071	1.070	0.028	0.031	0.034	99.23	99.14	99.05
1.50	1.35	1.339	1.337	1.334	0.036	0.045	0.055	99.21	99.00	98.78
1.70	1.53	1.506	1.499	1.493	0.080	0.102	0.125	98.43	98.00	97.55
2.00	1.80	1.746	1.734	1.728	0.180	0.220	0.240	97.01	96.33	96.00
2.30	2.07	1.934	1.922	1.910	0.454	0.494	0.534	93.41	92.84	92.26
2.50	2.25	1.885	1.880	1.870	1.217	1.235	1.266	83.78	83.53	83.12
2.80	2.52	1.955	1.937	1.920	1.884	1.944	2.000	77.57	76.86	76.19
3.00	2.70	2.045	1.959	1.934	2.183	2.470	2.555	75.74	72.56	71.61

Table S15. Isothermal adsorption of Na-MT1 for OTAC at different temperature.

Amount		Adsorbance, mmol/g			Equilibrium concentration, mmol/L			Adsorption efficiency η , %		
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CEC	mmol/g	25°C	50°C	80°C	25°C	50°C	80°C	25°C	50°C	80°C
0.50	0.45	0.448	0.448	0.447	0.006	0.007	0.010	99.62	99.52	99.34
0.70	0.63	0.627	0.627	0.626	0.009	0.011	0.014	99.59	99.48	99.32
1.00	0.90	0.897	0.895	0.895	0.011	0.016	0.016	99.62	99.48	99.48
1.30	1.17	1.074	1.073	1.071	0.021	0.023	0.030	99.41	99.37	99.17
1.50	1.35	1.337	1.335	1.330	0.043	0.051	0.065	99.06	98.87	98.55
1.70	1.53	1.507	1.504	1.496	0.075	0.086	0.115	98.53	98.31	97.75
2.00	1.80	1.762	1.758	1.745	0.126	0.140	0.183	97.90	97.66	96.96
2.30	2.07	1.971	1.956	1.944	0.330	0.379	0.422	95.22	94.50	93.89
2.50	2.25	2.011	1.998	1.994	0.798	0.840	0.855	89.36	88.80	88.61
2.80	2.52	2.039	2.034	2.026	1.604	1.618	1.647	80.90	80.73	80.40
3.00	2.70	2.084	2.036	2.021	2.053	2.213	2.265	77.19	75.42	74.83

Table S16. Isothermal adsorption of Na-MT2 for DTAC at different temperature.

Amount	Adsorbance, mmol/g	Equilibrium			Adsorption efficiency η , %					
		concentration, mmol/L			25°C	50°C	80°C	25°C	50°C	80°C
CEC	mmol/g	25°C	50°C	80°C	25°C	50°C	80°C	25°C	50°C	80°C
0.50	0.55	0.543	0.542	0.542	0.011	0.015	0.017	99.60	99.47	99.38
0.70	0.76	0.759	0.758	0.757	0.021	0.024	0.029	99.46	99.37	99.24
1.00	1.09	1.074	1.073	1.073	0.082	0.085	0.086	98.49	98.44	98.42
1.30	1.42	1.371	1.369	1.368	0.232	0.242	0.247	96.72	96.59	96.52
1.50	1.64	1.559	1.557	1.552	0.380	0.392	0.416	95.35	95.21	94.92
1.70	1.85	1.739	1.732	1.728	0.568	0.604	0.627	93.87	93.48	93.23
2.00	2.18	1.958	1.951	1.943	1.111	1.145	1.184	89.81	89.49	89.13
2.30	2.51	2.010	1.980	1.961	2.484	2.636	2.731	80.18	78.97	78.21
2.50	2.73	2.082	2.027	1.979	3.216	3.490	3.728	76.40	74.39	72.64
2.80	3.05	2.144	2.096	2.001	4.540	4.778	5.254	70.25	68.69	65.57
3.00	3.27	2.155	2.119	2.024	5.576	5.754	6.230	65.90	64.81	61.89

Table S17. Isothermal adsorption of Na-MT2 for TTAC at different temperature.

Amount	Adsorbance, mmol/g	Equilibrium			Adsorption efficiency η , %					
		concentration, mmol/L			25°C	50°C	80°C	25°C	50°C	80°C
CEC	mmol/g	25°C	50°C	80°C	25°C	50°C	80°C	25°C	50°C	80°C
0.50	0.55	0.543	0.543	0.542	0.009	0.010	0.013	99.66	99.62	99.52
0.70	0.76	0.759	0.759	0.758	0.022	0.021	0.026	99.42	99.46	99.32
1.00	1.09	1.083	1.083	1.082	0.035	0.035	0.040	99.36	99.36	99.27
1.30	1.42	1.405	1.405	1.403	0.059	0.060	0.069	99.16	99.15	99.02
1.50	1.64	1.600	1.595	1.590	0.177	0.198	0.223	97.83	97.58	97.27
1.70	1.85	1.807	1.802	1.799	0.231	0.257	0.270	97.51	97.23	97.09
2.00	2.18	2.056	2.052	2.039	0.618	0.639	0.703	94.33	94.14	93.55
2.30	2.51	2.157	2.151	2.149	1.750	1.779	1.790	86.04	85.81	85.72
2.50	2.73	2.251	2.214	2.174	2.369	2.553	2.754	82.61	81.26	79.79
2.80	3.05	2.209	2.198	2.193	4.214	4.268	4.293	72.39	72.03	71.86
3.00	3.27	2.292	2.250	2.199	4.891	5.099	5.355	70.08	68.81	67.24

Table S18. Isothermal adsorption of Na-MT2 for CTAC at different temperature.

Amount		Adsorbance, mmol/g			Equilibrium concentration, mmol/L			Adsorption efficiency η , %		
					25°C	50°C	80°C			
CEC	mmol/g	25°C	50°C	80°C	25°C	50°C	80°C	25°C	50°C	80°C
0.50	0.55	0.544	0.543	0.543	0.006	0.008	0.011	99.77	99.71	99.59
0.70	0.76	0.761	0.760	0.759	0.011	0.013	0.018	99.71	99.66	99.53
1.00	1.09	1.084	1.085	1.084	0.029	0.026	0.032	99.46	99.52	99.40
1.30	1.42	1.410	1.409	1.407	0.036	0.041	0.049	99.50	99.43	99.31
1.50	1.64	1.620	1.618	1.616	0.077	0.086	0.096	99.06	98.94	98.82
1.70	1.85	1.822	1.819	1.816	0.154	0.170	0.186	98.34	98.17	97.99
2.00	2.18	2.104	2.099	2.095	0.382	0.407	0.423	96.49	96.27	96.12
2.30	2.51	2.342	2.334	2.321	0.824	0.865	0.930	93.43	93.10	92.58
2.50	2.73	2.408	2.402	2.392	1.585	1.616	1.666	88.37	88.14	87.77
2.80	3.05	2.437	2.414	2.401	3.073	3.188	3.253	79.86	79.11	78.68
3.00	3.27	2.508	2.443	2.410	3.809	4.136	4.300	76.70	74.70	73.70

Table S19. Isothermal adsorption of Na-MT2 for OTAC at different temperature.

Amount		Adsorbance, mmol/g			Equilibrium concentration, mmol/L			Adsorption efficiency η , %		
					25°C	50°C	80°C			
CEC	mmol/g	25°C	50°C	80°C	25°C	50°C	80°C	25°C	50°C	80°C
0.50	0.55	0.544	0.544	0.544	0.002	0.003	0.004	99.89	99.84	99.76
0.70	0.76	0.762	0.761	0.760	0.004	0.007	0.009	99.83	99.72	99.66
1.00	1.09	1.087	1.087	1.086	0.009	0.010	0.014	99.76	99.73	99.61
1.30	1.42	1.412	1.411	1.410	0.016	0.020	0.023	99.67	99.58	99.52
1.50	1.64	1.630	1.629	1.627	0.017	0.021	0.026	99.69	99.61	99.53
1.70	1.85	1.838	1.836	1.832	0.050	0.057	0.071	99.20	99.08	98.85
2.00	2.18	2.151	2.148	2.139	0.096	0.108	0.136	98.68	98.52	98.13
2.30	2.51	2.427	2.420	2.403	0.267	0.289	0.345	96.80	96.55	95.87
2.50	2.73	2.507	2.490	2.481	0.727	0.784	0.812	91.99	91.37	91.06
2.80	3.05	2.520	2.511	2.499	1.774	1.802	1.845	82.56	82.28	81.87
3.00	3.27	2.555	2.543	2.513	2.382	2.425	2.524	78.14	77.75	76.85

Table S20. Adsorption thermodynamic parameters of Na-MT1 for DTAC.

Amount (CEC)	ΔS J/(K•mol)	ΔH kJ/mol	ΔG , kJ/mol		
			298k	323k	353k
0.5	11.631	-5.778	-9.244	-9.535	-9.884
0.7	11.872	-5.889	-9.143	-9.635	-10.226
1.0	18.532	-2.151	-7.940	-8.219	-8.554
1.3	13.369	-1.443	-5.427	-5.761	-6.162
1.5	8.929	-0.601	-3.262	-3.485	-3.753

1.7	5.504	-1.195	-2.835	-2.973	-3.138
2.0	1.064	-0.642	-0.959	-0.986	-1.018
2.3	-6.294	-1.761	0.115	0.272	0.461
2.5	-13.959	-3.650	0.510	0.859	1.278
2.8	-12.371	-2.236	1.451	1.760	2.131
3.0	-13.236	-2.037	1.907	2.238	2.635

Table S21. Adsorption thermodynamic parameters of Na-MT1 for TTAC.

Amount (CEC)	ΔS J/(K•mol)	ΔH kJ/mol	ΔG , kJ/mol		
			298k	323k	353k
0.5	13.286	-5.614	-9.573	-9.905	-10.304
0.7	19.022	-2.592	-8.261	-8.736	-9.307
1.0	21.758	-1.887	-8.371	-8.915	-9.568
1.3	9.736	-2.669	-5.570	-5.814	-6.106
1.5	2.777	-3.270	-4.098	-4.167	-4.250
1.7	1.746	-2.956	-3.476	-3.520	-3.572
2.0	0.507	-1.384	-1.535	-1.548	-1.563
2.3	0.374	-0.177	-0.288	-0.298	-0.309
2.5	-7.790	-2.148	0.173	0.368	0.602
2.8	-9.112	-1.663	1.052	1.280	1.554
3.0	-11.997	-2.045	1.530	1.830	2.190

Table S22. Adsorption thermodynamic parameters of Na-MT1 for CTAC.

Amount (CEC)	ΔS J/(K•mol)	ΔH kJ/mol	ΔG , kJ/mol		
			298k	323k	353k
0.5	14.956	-5.514	-9.972	-10.346	-10.794
0.7	17.633	-4.383	-9.642	-10.082	-10.611
1.0	23.345	-2.161	-9.118	-9.701	-10.402
1.3	18.955	-3.417	-9.063	-9.537	-10.105
1.5	6.867	-6.910	-8.962	-9.134	-9.340
1.7	1.896	-7.261	-7.826	-7.873	-7.930
2.0	2.752	-4.764	-5.584	-5.653	-5.735
2.3	2.760	-2.762	-3.584	-3.653	-3.736
2.5	1.122	-0.754	-1.088	-1.116	-1.150
2.8	-3.849	-1.236	-0.089	0.007	0.123

3.0	-12.080	-3.388	0.212	0.514	0.876
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Table S23. Adsorption thermodynamic parameters of Na-MT1 for OTAC.

Amount (CEC)	ΔS J/(K•mol)	ΔH kJ/mol	ΔG , kJ/mol		
			298k	323k	353k
0.5	6.660	-8.863	-10.848	-11.014	-11.214
0.7	8.480	-8.114	-10.641	-10.853	-11.107
1.0	18.914	-5.047	-10.683	-11.156	-11.724
1.3	14.832	-5.379	-9.799	-10.170	-10.615
1.5	5.703	-6.871	-8.570	-8.713	-8.884
1.7	2.087	-6.867	-7.489	-7.541	-7.604
2.0	1.829	-6.061	-6.606	-6.652	-6.707
2.3	0.939	-4.135	-4.415	-4.438	-4.466
2.5	3.525	-1.223	-2.273	-2.362	-2.467
2.8	0.283	-0.515	-0.599	-0.606	-0.615
3.0	-6.842	-2.055	-0.274	0.047	0.433

Table S24. Adsorption thermodynamic parameters of Na-MT2 for DTAC.

Amount (CEC)	ΔS J/(K•mol)	ΔH kJ/mol	ΔG , kJ/mol		
			298k	323k	353k
0.5	8.971	-0.698	-3.371	-3.596	-3.865
0.7	11.665	-5.455	-8.931	-9.223	-9.573
1.0	18.948	-0.685	-6.332	-6.805	-7.374
1.3	11.432	-0.981	-4.388	-4.674	-5.016
1.5	6.734	-1.502	-3.509	-3.677	-3.879
1.7	3.592	-1.693	-2.763	-2.853	-2.961
2.0	0.881	-1.226	-1.489	-1.511	-1.537
2.3	-8.198	-1.906	0.537	0.742	0.988
2.5	-14.342	-3.159	1.115	1.473	1.904
2.8	-17.809	-3.442	1.865	2.310	2.845
3.0	-22.780	-4.677	2.111	2.681	3.364

Table S25. Adsorption thermodynamic parameters of Na-MT2 for TTAC.

Amount (CEC)	ΔS J/(K•mol)	ΔH kJ/mol	ΔG , kJ/mol		
			298k	323k	353k

0.5	15.181	-5.604	-10.128	-10.507	-10.963
0.7	21.059	-2.594	-8.870	-9.396	-10.028
1.0	21.292	-2.203	-8.548	-9.080	-9.719
1.3	11.119	-2.569	-5.882	-6.160	-6.494
1.5	5.637	-3.775	-5.455	-5.596	-5.765
1.7	8.572	-2.515	-5.069	-5.284	-5.541
2.0	2.785	-2.174	-3.004	-3.074	-3.157
2.3	0.324	-0.416	-0.513	-0.521	-0.530
2.5	-10.309	-2.946	0.126	0.384	0.693
2.8	-6.768	-0.495	1.522	1.691	1.894
3.0	-13.336	-2.100	1.874	2.208	2.608

Table S26. Adsorption thermodynamic parameters of Na-MT2 for CTAC.

Amount (CEC)	ΔS J/(K•mol)	ΔH kJ/mol	ΔG , kJ/mol		
			298k	323k	353k
0.5	6.327	-9.179	-11.064	-11.223	-11.412
0.7	10.609	-7.341	-10.502	-10.768	-11.086
1.0	24.718	-1.723	-9.089	-9.707	-10.448
1.3	13.119	-4.997	-8.906	-9.234	-9.628
1.5	12.970	-3.666	-7.531	-7.855	-8.244
1.7	10.135	-3.128	-6.148	-6.402	-6.706
2.0	8.514	-1.676	-4.213	-4.426	-4.681
2.3	1.754	-2.075	-2.598	-2.642	-2.694
2.5	0.449	-0.909	-1.043	-1.054	-1.067
2.8	-5.570	-1.141	0.519	0.658	0.825
3.0	-10.093	-1.857	1.151	1.403	1.706

Table S27. Adsorption thermodynamic parameters of Na-MT2 for OTAC.

Amount (CEC)	ΔS J/(K•mol)	ΔH kJ/mol	ΔG , kJ/mol		
			298k	323k	353k
0.5	2.927	-13.117	-13.989	-14.062	-14.150
0.7	5.878	-10.900	-12.652	-12.799	-12.975
1.0	13.294	-8.106	-12.068	-12.400	-12.799
1.3	17.301	-5.956	-11.112	-11.544	-12.063
1.5	16.212	-6.449	-11.280	-11.685	-12.172

1.7	10.958	-5.723	-8.988	-9.262	-9.591
2.0	7.300	-5.572	-7.747	-7.930	-8.149
2.3	4.332	-4.218	-5.509	-5.617	-5.747
2.5	3.799	-1.916	-3.048	-3.143	-3.257
2.8	0.391	-0.756	-0.873	-0.882	-0.894
3.0	-3.351	-1.185	-0.186	-0.103	-0.002

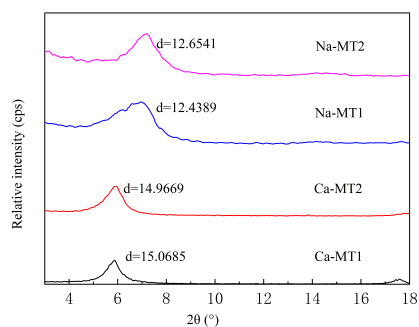
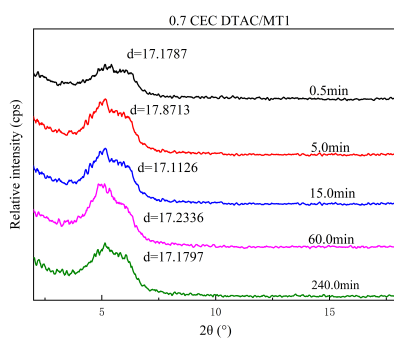
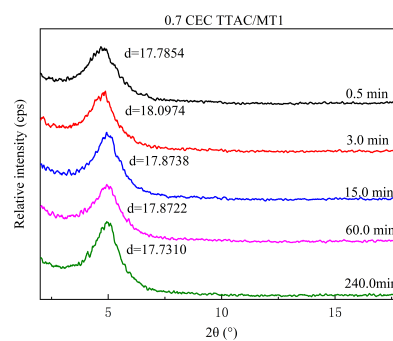


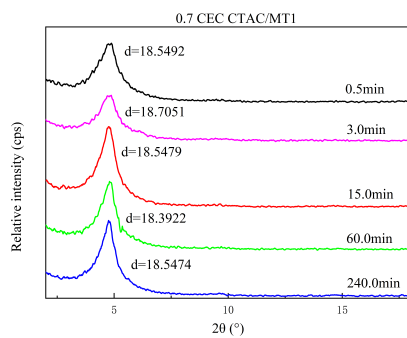
Figure S1. XRD patterns of different types of MT.



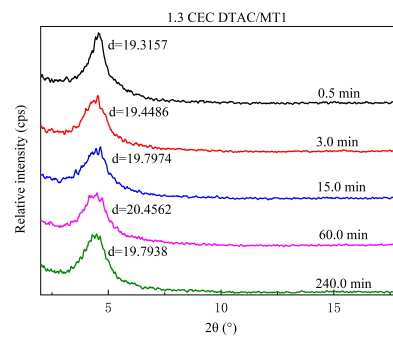
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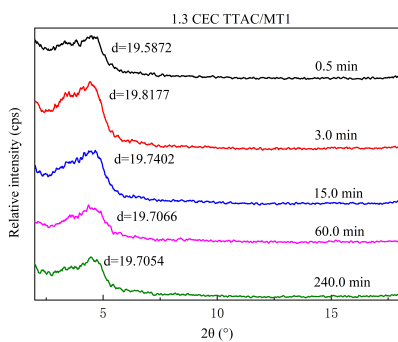
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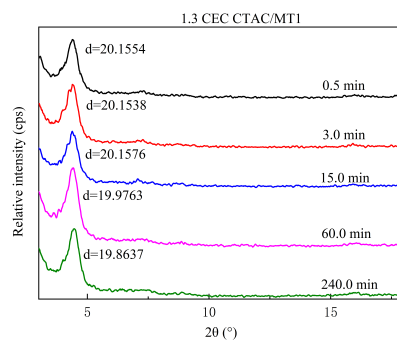
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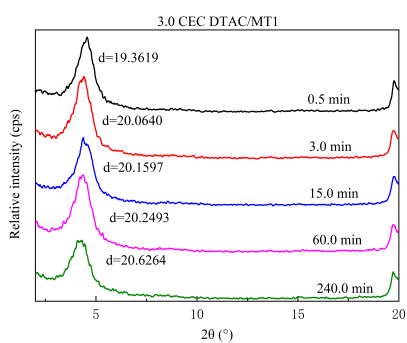
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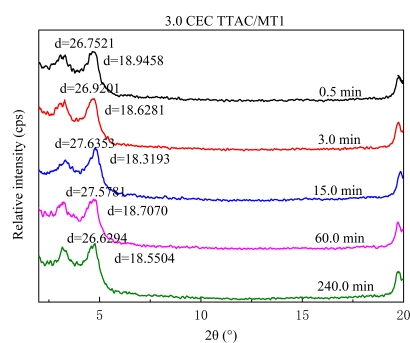
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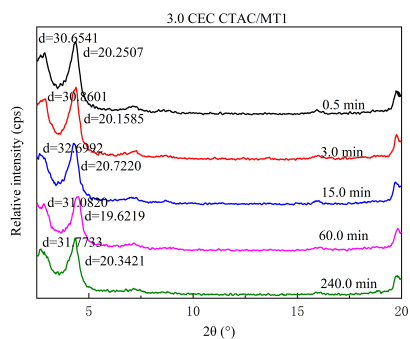
(f)



(g)



(h)



(i)

Figure S2. XRD patterns of alkylammonium/Na-MT1 prepared under different conditions, (a) 0.7 CEC, DTAC/MT1, (b) 0.7 CEC, TTAC/MT1, (c) 0.7 CEC, CTAC/MT1, (d) 1.3 CEC, DTAC/MT1, (e) 1.3 CEC, TTAC/MT1, (f) 1.3 CEC, CTAC/MT1, (g) 3.0 CEC, DTAC/MT1, (h) 3.0 CEC, TTAC/MT1, (i) 3.0 CEC, CTAC/MT1.