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[C_2mim][Ala]丙氨酸离子液体水溶液粘滞流动的活化参数

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Parameters of the Activation of Viscous Flow of Aqueous [C_2mim][Ala]

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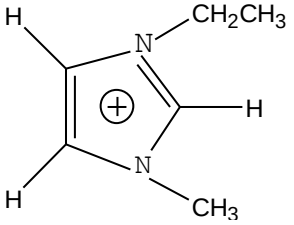
表 S1　[C_2mim][Ala]离子液体的 ^{1}H NMR 表征

Table S1　^{1}H NMR of IL [C_2mim][Ala]



$CH_3CH(NH_2)COO^-$

Chemical shift	Hydrogen number	Radical
1.230-1.254 (d)	3	C**H$_3$**CH(NH$_2$)COO$^-$
1.475-1.525 (t)	3	N-CH$_2$C**H$_3$**
3.307-3.378 (m)	1	CH$_3$C**H**(NH$_2$)COO$^-$
3.892 (s)	3	C**H$_3$**-N
4.191-4.265 (m)	2	N-C**H$_2$**CH$_3$
7.419-7.425 (d)	1	N-C**H**=CH-N
7.487-7.493 (d)	1	N-CH=C**H**-N

表 S2　288.15-328.15 K 不同浓度[C_2mim][Ala]溶液的平均摩尔体积(10^5V_m)

Table S2　Values of the average molar volume (10^5V_m) for aqueous [C_2mim][Ala] with various molalities

m	$10^5V_m/(m^3\cdot mol^{-1})$								
/(mol·kg^{-1})	288.15 K	293.15 K	298.15 K	303.15 K	308.15 K	313.15 K	318.15 K	323.15 K	328.15 K
0.0163	1.8076	1.8093	1.8115	1.8140	1.8170	1.8203	1.8240	1.8280	1.8323
0.0220	1.8092	1.8109	1.8130	1.8156	1.8186	1.8219	1.8256	1.8296	1.8340
0.0278	1.8108	1.8125	1.8147	1.8173	1.8202	1.8236	1.8273	1.8313	1.8356
0.0556	1.8185	1.8203	1.8225	1.8251	1.8281	1.8315	1.8352	1.8393	1.8437
0.1670	1.8490	1.8510	1.8535	1.8563	1.8594	1.8629	1.8667	1.8709	1.8754
0.2789	1.8790	1.8813	1.8842	1.8872	1.8905	1.8941	1.8980	1.9022	1.9069
0.3914	1.9090	1.9115	1.9146	1.9177	1.9213	1.9250	1.9290	1.9332	1.9380
0.5040	1.9388	1.9416	1.9449	1.9482	1.9519	1.9556	1.9598	1.9643	1.9690
0.6173	1.9683	1.9714	1.9749	1.9785	1.9823	1.9862	1.9905	1.9951	1.9999
0.7312	1.9977	2.0010	2.0049	2.0087	2.0128	2.0166	2.0210	2.0257	2.0305
0.8452	2.0272	2.0303	2.0347	2.0387	2.0429	2.0469	2.0515	2.0562	2.0611
1.0079	2.0686	2.0721	2.0768	2.0810	2.0852	2.0896	2.0942	2.0992	2.1042

表 S3　288.15-328.15 K 不同浓度[C_2mim][Ala]溶液的表观摩尔体积($^{\phi}V_B$)

Table S3　Values of apparent molar volume ($^{\phi}V_B$) for aqueous [C_2mim][Ala] with various molalities

m/	$^{\phi}V_B$/(cm^3 mol^{-1})								
(mol ⱪg^{-1})	288.15 K	293.15 K	298.15 K	303.15 K	308.15 K	313.15 K	318.15 K	323.15 K	328.15 K
0.0163	173.0	174.3	175.7	176.6	177.4	177.7	178.7	179.0	179.4
0.0220	172.9	174.0	175.5	176.2	177.3	177.6	178.4	178.7	179.1
0.0278	172.6	173.9	175.1	176.1	177.0	177.3	178.0	178.7	179.1
0.0556	172.1	173.4	174.8	175.8	176.6	177.2	177.7	178.2	178.8
0.1670	170.9	172.3	173.7	174.7	175.3	175.9	176.5	177.1	177.6
0.2789	169.9	171.3	172.9	173.8	174.5	175.0	175.7	176.1	176.9
0.3914	169.3	170.6	172.0	172.9	173.7	174.3	174.9	175.3	176.0
0.5040	168.8	170.2	171.5	172.4	173.2	173.7	174.4	174.9	175.5
0.6173	168.3	169.6	170.9	171.9	172.8	173.2	173.9	174.4	174.9
0.7312	167.7	169.0	170.4	171.4	172.3	172.8	173.4	173.9	174.4
0.8452	167.4	168.4	170.0	171.0	171.9	172.4	173.0	173.6	174.0
1.0079	166.9	168.0	169.5	170.4	171.1	171.8	172.4	173.0	173.4
a_0 =	173.8	175.1	176.5	177.3	178.3	178.6	179.4	179.8	180.3
a_1	-7.043	-7.116	-7.065	-6.887	-7.044	-6.818	-6.973	-6.881	-6.821
r^2	0.9980	0.9986	0.9982	0.9979	0.9988	0.9984	0.9979	0.9986	0.9981
s	0.1058	0.0880	0.1009	0.1059	0.0822	0.0920	0.1062	0.0878	0.0996

表 S4　用测定的溶液密度数据换算的物质的量浓度(c)

Table S4　Values of concentration of substance (c) converted by the measured solution density

m	c/(mol dm^{-3})								
/(mol ⱪg^{-1})	288.15 K	293.15 K	298.15 K	303.15 K	308.15 K	313.15 K	318.15 K	323.15 K	328.15 K
0.0163	0.0163	0.0163	0.0162	0.0162	0.0162	0.0162	0.0161	0.0161	0.0160
0.0220	0.0219	0.0219	0.0218	0.0218	0.0218	0.0217	0.0217	0.0216	0.0216
0.0278	0.0276	0.0276	0.0276	0.0275	0.0275	0.0274	0.0274	0.0273	0.0273
0.0556	0.0550	0.0550	0.0549	0.0548	0.0547	0.0546	0.0545	0.0544	0.0543
0.1670	0.1623	0.1621	0.1619	0.1616	0.1613	0.1610	0.1607	0.1603	0.1600
0.2789	0.2661	0.2658	0.2654	0.2650	0.2645	0.2640	0.2634	0.2629	0.2622
0.3914	0.3668	0.3663	0.3657	0.3651	0.3644	0.3637	0.3630	0.3622	0.3613
0.5040	0.4641	0.4635	0.4627	0.4619	0.4610	0.4601	0.4591	0.4581	0.4570
0.6173	0.5588	0.5579	0.5569	0.5559	0.5548	0.5537	0.5525	0.5513	0.5499
0.7312	0.6509	0.6498	0.6485	0.6473	0.6460	0.6448	0.6433	0.6419	0.6403
0.8452	0.7398	0.7387	0.7371	0.7357	0.7342	0.7327	0.7311	0.7294	0.7277
1.0079	0.8621	0.8607	0.8587	0.8570	0.8553	0.8534	0.8516	0.8495	0.8475

表 S5　[C_2mim][Ala]水溶液的外推函数值(η')

Table S5　Values of extrapolation function (η') for aqueous [C_2mim][Ala]

m /(mol·kg^{-1})	η'/(L$^{1/2}$·mol$^{-1/2}$)								
	288.15 K	293.15 K	298.15 K	303.15 K	308.15 K	313.15 K	318.15 K	323.15 K	328.15 K
0.0163	0.1151	0.1082	0.1017	0.1012	0.0955	0.0927	0.0898	0.0870	0.0857
0.0220	0.1377	0.1316	0.1229	0.1225	0.1173	0.1143	0.1104	0.1065	0.1055
0.0278	0.1563	0.1523	0.1457	0.1432	0.1380	0.1320	0.1291	0.1250	0.1285
0.0556	0.2416	0.2332	0.2282	0.2169	0.2193	0.2107	0.2101	0.1959	0.2113
0.1670	0.4857	0.4846	0.4681	0.4375	0.4275	0.4072	0.3869	0.3767	0.3787
0.2789	0.6373	0.6273	0.5974	0.5576	0.5377	0.5227	0.5020	0.4925	0.4682
0.3914	0.7538	0.7338	0.7141	0.6648	0.6448	0.6150	0.5853	0.5756	0.5558
0.5040	0.8810	0.8414	0.7922	0.7577	0.7230	0.6933	0.6734	0.6341	0.6242
0.6173	0.9633	0.9308	0.8875	0.8458	0.8022	0.7727	0.7530	0.7030	0.7012
0.7312	1.0492	1.0133	0.9657	0.9066	0.8844	0.8346	0.8171	0.7792	0.7603
0.8452	1.1328	1.0927	1.0332	0.9882	0.9517	0.9054	0.8672	0.8154	0.8095
1.0079	1.2517	1.1927	1.1382	1.0916	1.0413	0.9999	0.9427	0.8967	0.8599

表 S6　用方程(9)预测[C_2mim][Ala]水溶液的粘度值(η_{pre})

Table S6　Predicted values of viscosity (η_{pre}) for aqueous [C_2mim][Ala] by eq. (9)

m /(mol·kg^{-1})	η_{pre}/(μPa s)								
	288.15 K	293.15 K	298.15 K	303.15 K	308.15 K	313.15 K	318.15 K	323.15 K	328.15 K
0.0167	1153.2	1014.7	900.8	808.7	727.3	660.6	603.3	553.7	510.5
0.0222	1160.3	1020.8	906.0	813.2	731.3	664.1	606.4	556.4	512.9
0.0278	1167.8	1027.2	911.5	818.0	735.4	667.7	609.6	559.2	515.4
0.0556	1205.1	1058.9	938.7	841.6	755.8	685.5	625.2	573.0	527.6
0.1670	1360.2	1190.4	1051.1	938.4	839.4	758.1	688.6	628.4	576.2
0.2789	1514.9	1321.4	1162.7	1034.5	922.1	829.9	751.0	682.9	623.8
0.3914	1666.7	1449.7	1272.0	1128.5	1002.9	899.9	812.0	736.0	670.2
0.5040	1814.5	1574.6	1378.3	1219.9	1081.4	968.0	871.1	787.5	715.1
0.6173	1958.8	1696.6	1482.1	1309.0	1158.0	1034.2	928.6	837.6	758.8
0.7312	2099.7	1815.6	1583.3	1395.9	1232.6	1098.8	984.7	886.4	801.4
0.8452	2236.2	1931.0	1681.3	1480.0	1304.8	1161.3	1039.0	933.6	842.6
1.0079	2424.3	2089.7	1816.2	1595.8	1404.3	1247.3	1113.6	998.5	899.2

表 S7　利用新 Eyring 半经验方法预测的[C_2mim][Ala]溶液粘度值($\eta_{pre'}$)

Table S7　Predicted values of viscosity ($\eta_{pre'}$) for aqueous [C_2mim][Ala] by the new Eyring' semi-empirical method

m/ (mol kg^{-1})	$\eta_{pre'}$/(μPa s)								
	288.15 K	293.15 K	298.15 K	303.15 K	308.15 K	313.15 K	318.15 K	323.15 K	328.15 K
0.0163	1157.1	1018.2	903.9	810.6	728.9	662.5	604.4	555.2	512.3
0.0220	1164.2	1024.4	909.1	815.0	732.8	665.8	607.3	557.8	514.6
0.0278	1171.5	1030.7	914.4	819.6	736.8	669.2	610.4	560.5	517.0
0.0556	1206.8	1061.0	940.2	841.4	755.9	685.6	625.1	573.4	528.6
0.1670	1352.0	1185.6	1045.9	930.7	833.8	752.7	685.0	625.8	575.5
0.2789	1503.1	1314.6	1154.9	1022.8	913.6	821.5	746.1	679.2	623.3
0.3914	1658.0	1446.1	1265.8	1116.7	994.4	891.5	807.9	733.0	671.4
0.5040	1813.7	1577.5	1376.4	1210.4	1074.4	961.5	869.2	786.1	719.1
0.6173	1968.4	1707.1	1485.3	1303.1	1152.9	1030.7	929.3	838.2	765.8
0.7312	2119.0	1832.3	1590.4	1393.2	1228.3	1098.3	987.5	888.6	811.1
0.8452	2261.0	1949.6	1688.7	1478.6	1298.9	1162.5	1042.2	935.8	853.8
1.0079	2443.6	2097.7	1813.6	1588.9	1388.6	1246.7	1112.6	996.6	909.0

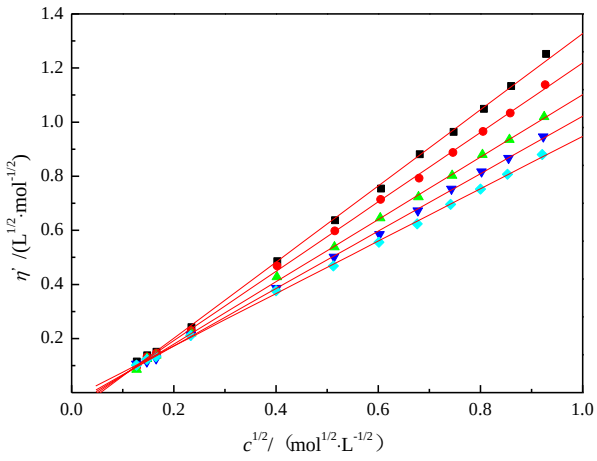


图 S1　288.15、298.15、308.15、318.15、328.15K 下外推函数 η'对 $c^{1/2}$ 作图

Fig.S1　Plotting extrapolation function，η' *vs* $c^{1/2}$ at T = (288.15, 298.15, 308.15, 318.15 and 328.15) K

■ 288.15 K; ● 298.15 K; ▲308.15 K; ▼318.15 K; ♦328.15 K