

Dielectric Relaxation of Aqueous Tetraalkylammonium Halide Solutions

Supplementary material — Relaxation parameters and relevant solution properties

To allow a better assessment of the scatter of the dielectric relaxation parameters (ε_i , τ_i) an additional figure beyond the significant number of decimal places is given for the parameters. The character ‘F’ following data indicates that this parameter was preset in the fitting procedure.

Table S1: Concentration, c , (in mol dm⁻³) density, ρ , (in kg dm⁻³) conductance, κ , (in $\Omega^{-1}\text{m}^{-1}$) viscosity, η , (in 10⁻³ Pa·s) dielectric relaxation parameters for dispersion steps $i = 1 - 3$, ε_i , τ_i , (in 10⁻¹²s) and ε_∞ , of a sum of three Debye equations and corresponding variance of the fit, s^2 , of aqueous Me₄NBr, Et₄NCl, and Et₄NBr, solutions at 25 °C.

c	ρ	κ	η	ε_1	τ_1	ε_2	τ_2	ε_3	τ_3	ε_∞	s^2
Me ₄ NBr											
0.1998	1.00485	1.8144	0.903	76.42	157	74.95	8.58	6.88	1.31	4.76	0.063
0.3995	1.01271	3.2976	0.914	74.42	128	71.77	8.78	6.83	1.18	4.50	0.073
0.5805	1.01982	4.4920	0.932	72.86	114	69.52	9.00	7.06	1.40	5.23	0.098
0.7990	1.02835	5.8009	0.952	70.81	124	67.17	9.33	7.68	1.71	5.33	0.058
0.9995	1.03626	6.8785	0.972	68.95	97.2	64.35	9.44	7.05	1.01	4.25	0.071
1.2984	1.04792	8.2894	1.014	65.29	106	60.28	9.91	7.49	1.42	4.57	0.061
1.7984	1.06780	10.180	1.100	59.59	81.3	54.09	10.5	7.58	1.68	5.38	0.043
2.4000	1.09186	11.650	1.252	51.98	43.9	46.19	11.4	7.90	1.95	5.65	0.027
2.9975	1.11622	12.257	1.478	44.77	42.3	38.64	12.0	7.24	1.06	4.52	0.028
Et ₄ NCl											
0.0656	0.99690	0.5742	0.915	77.71	226	76.58	8.54	6.54	0.8	3.91	0.108
0.1944	0.99688	1.503	0.965	74.32	131	73.67	8.88	6.53	0.6	1.93	0.114
0.5177	0.99736	3.249	1.110	69.03	69.6	66.36	9.71	6.52	4.3	5.9	0.132
0.979	0.99881	4.787	1.394	61.46	72.9	58.03	11.6	7.41	1.2	4.18	0.097
1.694	1.00433	5.673	2.142	50.16	81.0	45.81	15.8	8.67	4.2	5.51	0.069
2.230	1.00952	5.375	3.206	41.58	55.4	33.51	18.5	7.39	2.9	4.96	0.052
2.765	1.01641	4.547	5.236	34.07	65.3	25.29	23.9	7.35	3.5	4.99	0.038
3.2313	1.02278	3.558	8.800	28.76	76.0	16.40	25.0	6.85	2.8	4.72	0.030
3.6134	1.02806	2.713	14.40	24.12	79.3	10.38	18.7	6.50	2.6	4.73	0.021
Et ₄ NBr											
0.2136	1.00495	1.6036	0.964	75.49	94.2	73.05	8.84	6.62	2.1	5.46	0.104
0.5752	1.01879	3.3587	1.120	68.84	78.6	65.68	9.91	6.82	1.2	4.52	0.148
1.0559	1.03829	4.7347	1.399	61.24	59.5	56.95	12.2	10.2	4.6	5.59	0.065
1.5139	1.05793	5.3440	1.804	53.31	35.6	44.91	13.1	7.21	1.7	4.87	0.046

Table S2: Concentration, c , (in mol dm⁻³) density, ρ , (in kg dm⁻³) conductance, κ , (in $\Omega^{-1}\text{m}^{-1}$) viscosity, η , (in 10⁻³ Pa·s) dielectric relaxation parameters for dispersion steps $i = 1 - 4$, ε_i , τ_i , (in 10⁻¹²s) and ε_∞ , of a sum of four Debye equations and corresponding variance of the fit, s^2 , of aqueous Pr₄NBr, Bu₄NBr, and Pe₄NBr, solutions at 25 °C.

c	ρ	κ	η	ε_1	τ_1	ε_2	τ_2	ε_3	τ_3	ε_4	τ_4	ε_∞	s^2
Pr ₄ NBr													
0.2013	1.00269	1.2604	1.042	74.35	252	73.14	22.7	68.31	8.93	6.50	1.0F	4.50	0.097
0.4043	1.00905	1.9980	1.239	70.32	225	68.32	22.0	58.18	9.39	6.40	1.0F	4.30	0.040
0.6155	1.01615	2.4600	1.500	66.18	208	63.58	22.8	48.23	9.84	6.38	1.0F	4.28	0.055
0.8215	1.02347	2.7122	1.823	61.14	192	58.05	21.0	38.76	10.7	6.61	1.0F	4.24	0.043
1.0364	1.03162	2.8218	2.255	56.83	169	53.01	22.3	29.39	11.0	6.68	1.22	4.17	0.026
1.2910	1.04150	2.8017	2.947	51.43	172	47.26	25.0	24.29	13.1	7.24	1.51	4.02	0.014
1.5190	1.05068	2.6968	3.759	46.24	144	42.15	27.1	17.34	11.7	6.33	1.28	4.17	0.020
2.1525	1.07517	2.1435	7.813	33.17	122	29.44	40.9	12.45	14.3	6.09	1.57	4.04	0.008
2.5024	1.08738	1.7730	12.16	26.35	142	22.93	57.2	12.38	16.4	5.78	1.37	3.72	0.008
3.0002	1.10079	1.1554	26.63	19.76	295	16.49	69.1	9.13	14.6	5.56	1.34	3.80	0.006
Bu ₄ NBr													
0.2133	1.00220	1.1762	1.165	72.22	119	70.64	15.2	60.88	9.16	6.91	1.0F	4.59	0.027
0.5028	1.01042	1.8363	1.697	64.35	129	61.25	16.7	37.02	9.69	7.11	1.98	5.07	0.018
0.7938	1.01916	2.0395	2.513	56.18	116	52.28	19.2	23.86	10.1	7.03	2.04	4.82	0.031
0.9021	1.02209	2.0498	2.883	53.50	120	49.28	19.3	18.93	10.3	7.44	1.87	4.55	0.020
1.2003	1.03052	1.9772	4.357	44.44	90.2	39.82	22.4	13.57	9.27	6.24	1.95	4.65	0.014
1.6004	1.03964	1.7165	7.744	34.12	97.5	28.90	27.1	11.45	11.4	6.40	2.56	4.49	0.008
2.0006	1.04648	1.3213	14.72	25.10	123	20.26	33.7	9.90	12.1	5.85	2.15	4.21	0.007
2.3448	1.05085	0.8651	29.24	19.29	207	15.11	50.2	8.84	12.7	5.36	1.68	3.79	0.004
2.6924	1.05452	0.3352	80.94	15.39	404	10.95	76.2	6.93	12.9	4.93	1.69	3.78	0.002
Pe ₄ NBr													
0.04998	0.99777	0.36731	0.959	76.72	408	76.40	18.2	73.93	8.58	6.14	1.0F	4.44	0.106
0.10006	0.99861	0.64248	1.036	75.33	381	74.86	20.1	68.21	8.59	6.05	1.0F	4.24	0.098
0.15008	0.99955	0.85972	1.123	73.48	324	72.61	19.3	65.35	8.98	6.23	1.0F	4.15	0.107
0.20016	1.00049	1.03283	1.217	72.21	287	70.81	19.2	58.22	8.74	6.15	1.0F	3.89	0.041

Table S3: Temperature, T , (in K) density, ρ , (in kg dm^{-3}) conductance, κ , (in $\Omega^{-1}\text{m}^{-1}$) viscosity, η , (in $10^{-3}\text{Pa}\cdot\text{s}$) dielectric relaxation parameters for dispersion steps $i = 1 - 4$, ε_i , τ_i , (in 10^{-12}s) and ε_∞ , of a sum of four Debye equations and corresponding variance of the fit, s^2 , of aqueous Pr_4NBr at a molality of $m = 1.8503\text{ mol kg}^{-1}$, and Bu_4NBr at $m = 1.2335\text{ mol kg}^{-1}$.

T	ρ	κ	η	ε_1	τ_1	ε_2	τ_2	ε_3	τ_3	ε_4	τ_4	ε_∞	s^2
$\text{Pr}_4\text{NBr}, m = 1.8503\text{ mol kg}^{-1}$													
273.15	1.05270	0.9948	9.161	57.41	473	53.52	74.1	18.96	21.5	6.45	2.92	4.68	0.027
278.15	1.05074	1.2746	6.973	55.97	355	52.24	58.5	19.46	17.6	6.10	2.14	4.68	0.021
283.15	1.04868	1.5956	5.450	55.00	229	50.64	44.4	20.42	17.2	6.58	2.54	4.91	0.031
288.15	1.04638	1.9585	4.356	53.41	231	49.62	37.0	22.74	15.1	6.59	2.62	4.94	0.016
293.15	1.04403	2.3609	3.552	51.91	155	47.79	31.0	22.60	12.8	6.67	2.10	4.65	0.036
298.15	1.04150	2.8017	2.947	51.43	172	47.26	25.0	24.29	13.1	7.24	1.51	4.02	0.014
303.15	1.03877	3.2796	2.483	48.58	129	46.48	20.3	24.92	12.1	7.38	1.44	4.16	0.022
308.15	1.03605	3.7895	2.120	47.03	112	45.82	16.5	25.82	12.0	7.82	1.76	4.68	0.028
$\text{Bu}_4\text{NBr}, m = 1.2335\text{ mol kg}^{-1}$													
283.15	1.02990	1.1557	5.464	57.65	143	52.04	38.0	21.56	16.1	6.88	3.19	5.02	0.025
288.15	1.02743	1.4279	4.308	55.58	150	51.09	30.2	21.17	13.6	6.68	2.40	4.82	0.016
293.15	1.02483	1.7255	3.482	54.65	152	51.24	24.4	20.25	11.5	7.13	2.15	4.69	0.019
298.15	1.02209	2.0498	2.883	53.50	120	49.28	19.3	18.93	10.3	7.44	1.87	4.55	0.020
303.15	1.01929	2.4025	2.413	51.87	114	48.44	15.5	17.14	9.70	7.84	2.07	4.71	0.020
308.15	1.01643	2.7835	2.057	50.25	125	47.83	13.7	16.16	8.01	7.55	1.54	4.38	0.040