Dielectric Relaxation of Aqueous NaCl Solutions

Supplementary material — Relaxation parameters and relevant solution properties of aqueous NaCl solutions

Solution densities, ρ, needed for the interconversion of concentration scales and conductivities, κ, are interpolated from the regression functions provided by ELDAR [26].

To allow a better assessment of the scatter of the dielectric relaxation parameters (ε_i, τ_i, α) spectra recorded for a given concentration in different calibration series are individually fitted and an additional figure beyond the significant number of decimal places is given for the parameters. The character "F" following data of ε_∞ indicates that this parameter was preset in the fitting procedure. The meaning of the sample designation Xy is solution no. X, measurement series (independent calibration) y.

Table 3S: Molality, m, weight fraction, w, molar concentration, c, density, ρ, conductance, κ, dielectric relaxation parameters ε, τ, α, of a Cole-Cole equation and corresponding variance of the fit, s^2, of aqueous NaCl solutions at 5 °C.

m	w	c	ρ	κ	sample	ε	τ	α	ε_∞	s^2
0	0	0	1.00007	—	—	85.87	14.79	0	6.36	(a)
					05a	86.32	15.34	0	6.66	0.003
					05b	86.09	15.10	0	6.56	0.001
0.10393	0.006037	0.10377	1.00454	0.673	1a	84.69	15.21	0.009	6.14F	0.038
					1b	84.56	15.30	0.011	6.14F	0.044
0.20236	0.011688	0.20173	1.00873	1.277	2a	83.47	15.35	0.018	6.14F	0.077
					2b	83.09	15.22	0.016	6.14F	0.070
0.40299	0.023085	0.40047	1.01716	2.451	3a	80.57	15.33	0.026	6.14F	0.100
					3b	80.27	15.15	0.022	6.14F	0.083
0.60792	0.034308	0.60209	1.02560	3.584	4a	77.45	14.90	0.026	6.14F	0.062
					4b	77.33	14.33	0.027	6.14F	0.114
0.79573	0.044436	0.78562	1.03321	4.571	5a	74.91	14.70	0.032	6.14F	0.090
					5b	74.84	14.80	0.028	6.14F	0.043
1.00605	0.055529	0.98969	1.04158	5.885	6a	71.93	14.40	0.037	6.14F	0.114
					6b	72.08	14.52	0.034	6.14F	0.072
1.5273	0.081941	1.4886	1.06165	7.995	7a	66.42	13.79	0.044	6.14F	0.051
					7b	66.35	13.88	0.040	6.14F	0.038
2.0159	0.10539	1.9471	1.07966	9.951	8a	61.47	13.35	0.056	6.14F	0.094
					8b	61.40	13.55	0.051	6.14F	0.081
2.4834	0.12674	2.3773	1.09622	11.604	9a	57.21	13.04	0.063	6.14F	0.123
					9b	57.19	13.29	0.055	6.14F	0.104
3.0112	0.14964	2.8530	1.11417	13.237	10a	52.98	12.83	0.083	6.14F	0.157
					10b	52.81	12.82	0.070	6.14F	0.133
4.0361	0.19085	3.7460	1.14705	15.788	11a	46.03	12.12	0.107	6.14F	0.227
					11b	45.90	12.33	0.097	6.14F	0.193
5.1140	0.23010	4.6432	1.17928	17.721	12a	40.41	11.83	0.127	6.14F	0.227
					12b	40.14	11.98	0.125	6.14F	0.241

units: m in mol kg$_s^{-1}$, c in mol dm^{-3}, ρ in kg dm^{-3}, κ in Ω^{-1}m^{-1}, τ in 10^{-12}s; ρ and κ interpolated using ELDAR, κ extrapolated for $m > 0.9$ mol kg$_s^{-1}$; (a) calibration data

Table 4S: Molality, m, weight fraction, w, molar concentration, c, density, ρ, conductance, κ, dielectric relaxation parameters ε, τ, α, of a Cole-Cole equation and corresponding variance of the fit, s^2, of aqueous NaCl solutions at 20 °C.

m	w	c	ρ	κ	sample	ε	τ	α	ε_∞	s^2
0	0	0	0.99823	—	—	80.18	9.43	0	5.99	(a)
0.08563	0.004979	0.08535	1.00174	0.831	4a	79.35	9.48	0.020	5.6F	0.080
0.12764	0.007404	0.12713	1.00346	1.209	8c	78.63	9.20	0.012	5.6F	0.044
0.18480	0.010684	0.18388	1.00578	1.708	1b	78.48	9.33	0.022	5.6F	0.110
					1c	78.40	9.30	0.026	5.6F	0.314
0.22034	0.012713	0.21911	1.00722	2.011	9c	77.43	9.18	0.017	5.6F	0.055
0.27018	0.015344	0.26844	1.00923	2.428	5a	77.04	9.27	0.029	5.37	0.075
					5c	76.66	8.99	0.030	5.25	0.156
0.43004	0.024515	0.42605	1.01563	3.707	6a	75.17	9.37	0.024	5.6F	0.116
0.46467	0.026437	0.46282	1.02308	3.973	10c	74.44	9.01	0.026	5.6F	0.050
0.59939	0.033843	0.59203	1.02232	4.980	7c	73.21	8.91	0.036	5.6F	0.145
0.68509	0.038496	0.67562	1.02566	5.596	11d	71.83	8.76	0.035	5.28	0.038
0.80901	0.045144	0.79602	1.03046	6.456	12a	70.07	8.72	0.029	5.6F	0.078
					12b	70.19	8.75	0.034	5.6F	0.044
1.0094	0.055705	0.93807	1.03812	7.774	13a	68.25	8.66	0.037	5.6F	0.060
					13b	68.06	8.61	0.042	5.6F	0.063
1.5297	0.082060	1.4464	1.05744	10.825	14a	63.31	8.36	0.046	5.6F	0.121
					14b	63.10	8.37	0.054	5.6F	0.159
2.0169	0.10544	1.9393	1.07482	13.254	15a	59.07	8.14	0.050	5.6F	0.223
					15b	58.98	8.40	0.056	5.6F	0.324
2.5151	0.12815	2.3944	1.09192	15.367	16a	56.12	8.20	0.071	5.86	0.204
					16b	55.50	7.93	0.069	5.6F	0.283
3.0812	0.16697	2.8998	1.11060	17.369	17a	52.55	7.68	0.104	5.6F	0.265
					17b	52.76	8.07	0.102	5.6F	0.239
4.0268	0.19050	3.7166	1.14018	19.908	18a	47.47	7.45	0.140	5.6F	0.321
					18b	48.26	8.01	0.154	5.6F	0.263
5.0221	0.22690	4.5403	1.16940	21.687	19a	43.23	7.40	0.171	5.6F	0.349
					19b	43.84	7.82	0.180	5.6F	0.272

units: m in mol kg_s^{-1}, c in mol dm^{-3}, ρ in kg dm^{-3}, κ in $\Omega^{-1}m^{-1}$, τ in 10^{-12}s; ρ and κ interpolated using ELDAR; (a) calibration data

Table 5S: Molality, m, weight fraction, w, molar concentration, c, density, ρ, conductance, κ, dielectric relaxation parameters ε, τ, α, of a Cole-Cole equation and corresponding variance of the fit, s^2, of aqueous NaCl solutions at 25 °C.

m	w	c	ρ	κ	sample	ε	τ	α	ε_∞	s^2
0	0	0	0.99712	—	—	78.37	8.27	0	5.87	(a)
0.11140	0.006468	0.11086	1.00162	1.173	1a	76.48	8.02	0.000	5.65F	0.026
					1b	76.79	8.07	0.016	5.65F	0.031
0.19315	0.011162	0.19193	1.00491	1.963	2a	75.45	8.01	0.024	5.65F	0.077
					2b	75.71	7.99	0.010	5.65F	0.036
0.40827	0.023303	0.40412	1.01344	3.902	3a	72.59	7.81	0.009	5.65F	0.068
					3b	73.22	7.92	0.029	5.65F	0.036
0.60573	0.034189	0.59740	1.02114	5.546	4a	70.29	7.69	0.021	5.65F	0.118
					4b	70.80	7.72	0.030	5.65F	0.072
0.80912	0.045150	0.79496	1.02895	7.126	5a	68.22	7.57	0.038	5.65F	0.216
					5b	68.75	7.69	0.025	5.65F	0.063
0.99957	0.055191	0.97854	1.02895	8.512	6a	66.46	7.41	0.045	5.65F	0.213
					6b	66.82	7.52	0.036	5.65F	0.135
1.5040	0.08079	1.4581	1.05471	11.800	7a	62.18	7.35	0.032	5.65F	0.226
					7b	62.50	7.32	0.044	5.65F	0.157
2.0195	0.10556	1.9381	1.07294	14.654	8a	58.21	7.08	0.055	5.65F	0.333
					8b	58.39	7.04	0.059	5.65F	0.314
2.5195	0.12834	2.3937	1.08996	16.999	9a	55.24	6.86	0.088	5.65F	0.334
					9b	55.08	6.96	0.080	5.65F	0.299
3.0104	0.14961	2.8316	1.10608	18.944	10a	52.43	6.74	0.112	5.65F	0.333
					10b	52.75	7.04	0.085	5.65F	0.307
4.0303	0.19063	3.7118	1.13788	22.025	11a	47.37	6.63	0.150	5.65F	0.397
					11b	47.99	7.14	0.114	5.65F	0.476
5.0105	0.22649	4.5212	1.16658	23.979	12a	43.48	6.29	0.199	5.65F	0.439
					12b	44.63	6.70	0.196	5.65F	0.440

units: m in mol kg_s^{-1}, c in mol dm^{-3}, ρ in kg dm^{-3}, κ in $\Omega^{-1}m^{-1}$, τ in 10^{-12}s; ρ and κ interpolated using ELDAR; (a) calibration data

Table 6S: Molality, m, weight fraction, w, molar concentration, c, density, ρ, conductance, κ, dielectric relaxation parameters ε, τ, α, of a Cole-Cole equation and corresponding variance of the fit, s^2, of aqueous NaCl solutions at 35 °C.

m	w	c	ρ	κ	sample	ε	τ	α	ε_∞	s^2
0	0	0	0.99712	—	—	74.87	6.51	0	5.62	(a)
0.10096	0.0058656	0.10018	0.99811	1.339	1a	72.97	6.05	0.006	5.6F	0.037
					1b	73.57	6.30	0.008	5.6F	0.063
0.20098	0.011609	0.19904	1.00199	2.517	2a	71.67	5.86	0.011	5.6F	0.052
					2b	72.17	6.10	0.016	5.6F	0.082
0.40439	0.023087	0.39896	1.00988	4.719	3a	69.48	5.74	0.019	5.6F	0.065
					3b	69.89	5.95	0.022	5.6F	0.044
0.60714	0.034265	0.59667	1.01763	6.733	4a	67.36	5.62	0.019	5.6F	0.092
					4b	67.70	5.94	0.007	5.6F	0.072
0.79883	0.044601	0.78217	1.02485	8.505	5a	65.48	5.50	0.023	5.6F	0.145
					5b	65.80	5.87	0.006	5.6F	0.125
1.0025	0.055343	0.97769	1.03241	10.265	6a	64.09	5.37	0.088	5.6F	0.225
					6b	63.89	5.78	0.007	5.6F	0.208
1.5199	0.081576	1.4673	1.05116	14.247	7a	59.52	5.75	0.013	5.6F	0.362
					7b	60.38	5.65	0.054	5.6F	0.225
1.9968	0.10450	1.9094	1.06781	17.383	8a	56.95	5.52	0.047	5.6F	0.412
					8b	57.28	5.62	0.055	5.6F	0.284
2.5154	0.12816	2.3801	1.08531	20.295	9a	54.01	5.32	0.075	5.6F	0.468
					9b	54.40	5.67	0.067	5.6F	0.393
3.0359	0.15068	2.8420	1.10226	22.761	10a	50.93	5.38	0.075	5.6F	0.619
					10b	51.94	5.41	0.109	5.6F	0.371
4.0385	0.19094	3.7028	1.13331	26.422	11a	46.79	5.34	0.119	5.6F	0.739

units: m in mol kg_s^{-1}, c in mol dm^{-3}, ρ in kg dm^{-3}, κ in $\Omega^{-1}m^{-1}$, τ in 10^{-12}s; ρ and κ interpolated using ELDAR; (a) calibration data

Table 7S: Molar concentration, c, dielectric relaxation parameters ε, τ_1, ε_2, τ_2, ε_∞, of a superposition of two Debye equations and corresponding variance of the fit, s^2, of aqueous NaCl solutions at 5 °C.

c	sample	ε	τ_1	ε_2	τ_2	ε_∞	s^2
0.98969	6a	71.52	17.81	30.42	10.64	8.18	0.050
	6b	71.70	17.18	23.41	9.31	7.54	0.035
1.4886	7a	65.90	17.58	26.99	8.72	7.06	0.023
	7b	65.87	17.24	24.11	7.93	6.13	0.023
1.9471	8a	60.86	17.27	23.20	7.24	7.03	0.030
	8b	60.82	17.03	21.05	6.61	6.27	0.028
2.3773	9a	56.57	17.11	21.08	6.12	6.42	0.037
	9b	56.62	16.89	19.22	5.42	5.07	0.033
2.8530	10a	52.21	18.08	22.18	6.25	7.03	0.062
	10b	52.15	17.36	20.13	5.03	4.56	0.052
3.7460	11a	45.20	18.39	20.14	5.05	6.65	0.064
	11b	45.12	18.21	19.48	4.24	3.97	0.075
4.6432	12a	39.57	19.39	19.23	4.10	4.66	0.071
	12b	39.26	19.17	18.46	3.79	4.17	0.078

units: c in mol dm^{-3}, τ_1 and τ_2 in 10^{-12}s