

Supporting Information

Tunable-by-design copper oxide nanoparticles in ionic liquid nanofluids

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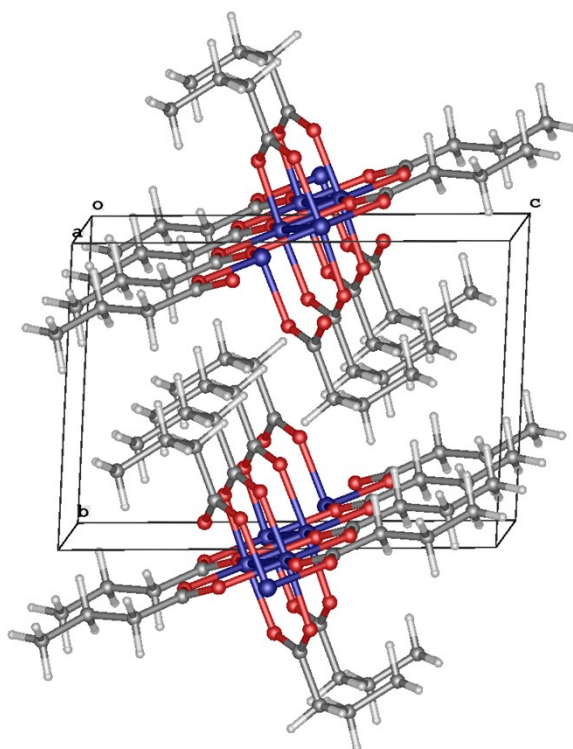


Figure S1. 1-D coordination polymer packing in the crystal structure of $\text{Cu}_2(\text{C}_3\text{H}_7\text{CO}_2)_4$.

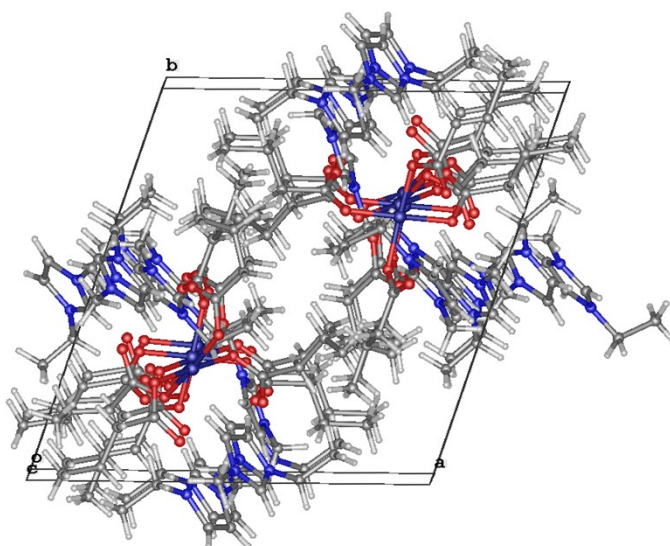


Figure S2. Square-planar coordination packing in the crystal structure of $[\text{C}_2\text{MIm}]_2[\text{Cu}(\text{C}_3\text{H}_7\text{CO}_2)_4]$.

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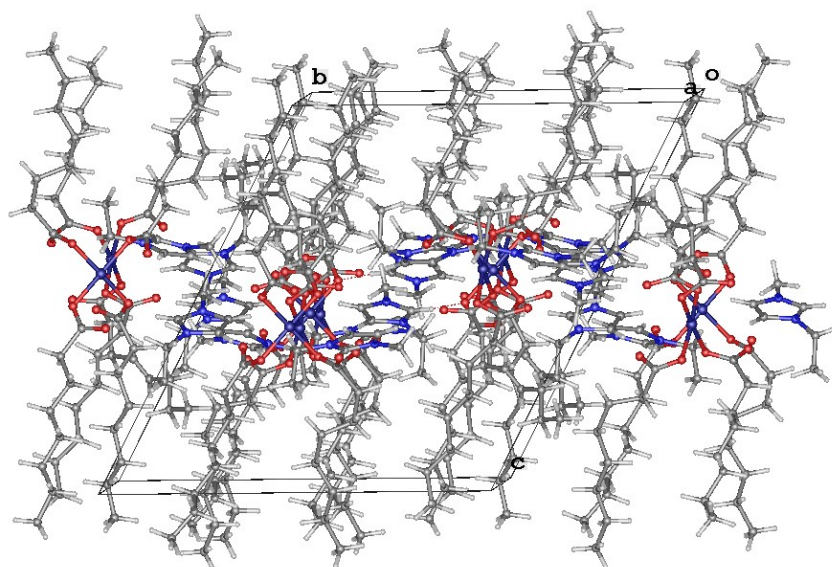


Figure S3. Square-planar coordination packing in the crystal structure of $[\text{C}_2\text{MIm}]_2[\text{Cu}(\text{C}_7\text{H}_{15}\text{CO}_2)_4]$.

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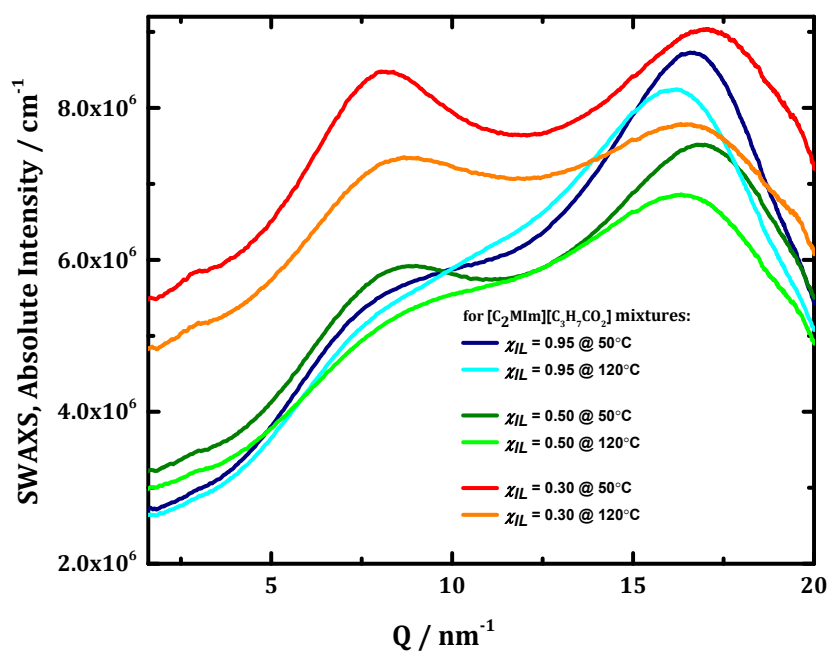


Figure S4. SWAXS patterns of $[\text{C}_2\text{MIm}][\text{C}_3\text{H}_7\text{CO}_2]$ in binary and ternary mixtures with water and copper(II) butanoate at 50°C for the composition $\chi_{\text{IL}} = 0.95$ (Blue), $\chi_{\text{IL}} = 0.50$ (green) and $\chi_{\text{IL}} = 0.30$ (red), and at 120°C for the composition $\chi_{\text{IL}} = 0.95$ (cyan), $\chi_{\text{IL}} = 0.50$ (green) and $\chi_{\text{IL}} = 0.30$ (orange).

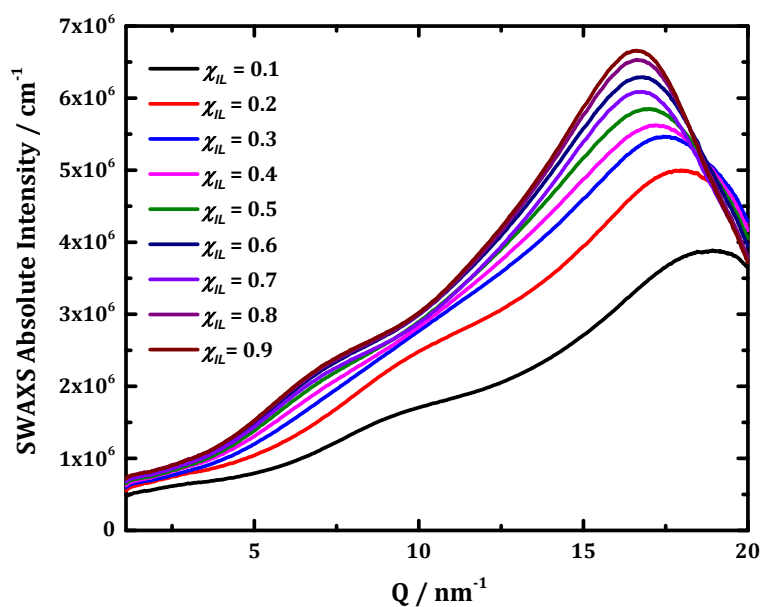


Figure S5. SWAXS patterns of water binary mixtures with $[\text{C}_2\text{MIm}][\text{CH}_3\text{CO}_2]$ for the composition $\chi_{\text{IL}} = 0.1$ to 1 at 25°C .

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Table S1. Density data for pure ionic liquids, and the respective copper salt and nanofluid solutions.

T/°C	ρ (g·cm ⁻³) of solutions containing [C ₂ MIm][CH ₃ CO ₂]			ρ (g·cm ⁻³) of solutions containing [C ₂ MIm][C ₃ H ₇ CO ₂]			ρ (g·cm ⁻³) of solutions containing [C ₂ MIm][C ₇ H ₁₅ CO ₂]		
	Pure IL	Copper salt	Nanofluid	Pure IL	Copper salt	Nanofluid	Pure IL	Copper salt	Nanofluid
20	1.0999	--	1.1245	1.0640	1.0762	1.0721	1.0053	1.0117	1.0103
25	1.0968	1.1255	1.1209	1.0610	1.0730	1.0688	1.0022	1.0090	1.0072
30	1.0936	1.1222	1.1173	1.0579	1.0698	1.0656	0.9991	1.0061	1.0040
40	1.0872	1.1155	1.1099	1.0514	1.0632	1.0590	0.9928	0.9998	0.9975
50	1.0810	1.1090	1.1022	1.0452	1.0567	1.0525	0.9866	0.9937	0.9910
60	1.0748	1.1026	1.0952	1.0390	1.0503	1.0462	0.9804	0.9875	0.9845
70	1.0687	1.0963	1.0883	1.0329	1.0440	1.0399	0.9743	0.9812	0.9779
80	1.0626	1.0899	1.0815	1.0269	1.0376	1.0336	0.9682	0.9748	0.9714
90	1.0567	1.0832	1.0748	1.0209	1.0310	1.0273	0.9622	0.9683	0.9646

Table S2. Temperature-dependent viscosity data for pure ILs and nanofluid solutions.

η (mPa·s) of solutions containing [C ₂ MIm][CH ₃ CO ₂]				η (mPa·s) of solutions containing [C ₂ MIm][C ₃ H ₇ CO ₂]				η (mPa·s) of solutions containing [C ₂ MIm][C ₇ H ₁₅ CO ₂]			
T/°C	IL	T/°C	Nanofluid	T/°C	IL	T/°C	Nanofluid	T/°C	IL	T/°C	Nanofluid
20.0	198.9	20.0	300.4	20.1	408.8	20.1	258.4	20.0	711.6	20.1	509.1
25.0	141.8	25.0	207.6	25.0	318.8	25.0	210.1	25.0	529.8	25.1	401.7
30.0	103.8	30.2	150.1	30.1	231.9	30.2	157.3	30.0	398.3	30.3	291.7
50.0	36.57	35.2	105.3	35.2	169.4	35.2	118.6	50.0	138.9	35.2	213.4
55.0	29.37	40.1	70.63	40.2	126.0	40.2	90.25	55.0	108.9	40.2	158.5
60.0	23.91	45.1	47.07	45.2	96.09	45.2	67.82	60.0	86.04	45.2	120.2
70.0	16.43	50.1	31.01	50.2	73.60	50.2	53.48	70.0	54.79	50.3	92.62
80.0	11.77	55.2	20.70	55.2	57.23	55.2	43.03	75.0	44.16	55.2	73.14
85.0	10.09	60.1	15.10	60.2	45.13	60.1	35.28	80.0	35.80	60.2	58.68
90.0	8.726	65.1	12.46	65.1	37.11	65.1	29.59	90.0	23.94	65.2	47.97
		70.1	11.12	70.1	31.21	70.1	24.99			70.2	39.70
		75.1	9.475	75.1	26.49	75.1	21.40			75.0	33.03
		80.1	8.250	80.1	22.46	80.1	18.36			80.0	27.28
		85.1	7.293	85.1	18.94	85.1	15.58			85.0	22.86
		90.0	6.493	90.1	15.81	90.0	13.13			90.0	19.13
		95.0	5.749	95.1	13.23	95.0	11.08			95.0	16.36
										99.9	14.40

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Table S3. VFT-fitting parameters determined by correlating viscosity data (Table S2) using the VFT equation (Eq. S1) as a function of temperature from 20 °C to 100 °C at 0.1 MPa.

	[C ₂ MIm][CH ₃ CO ₂]		[C ₂ MIm][C ₃ H ₇ CO ₂]		[C ₂ MIm][C ₇ H ₁₅ CO ₂]	
	IL	Nanofluid	IL	Nanofluid	IL	Nanofluid
<i>A</i> / mPa·s	0.03831	0.06335	0.02102	0.05896	0.01164	0.01722
<i>B</i> / K ⁻¹	1039.72	668.427	1385.54	1050.43	1772.15	1522.92
<i>T</i> ₀ / K	171.61	215.76	153.78	169.41	133.21	146.36

$$\eta = A \times \exp\left(\frac{B}{T - T_0}\right) \quad (\text{S1})$$