Electronic Supplementary Information for:

# Physicochemical Properties of Pentaglyme-Sodium Bis(trifluoromethanesulfonyl)amide Solvate Ionic Liquid

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The following supporting information summarizes the complete experimental data. Temperature-dependent TG curves for a series of glyme-Na[TFSA] mixtures are shown in **Figure S1**. $^1$H NMR spectra for the studied mixtures are depicted in **Figure S2**. Physicochemical properties of different glyme-Na[TFSA] binary mixtures at 30 °C are listed in **Table S1**. Physicochemical properties of $[Na(G5)_1][TFSA]$ at 60 °C are listed in **Table S2**. Ionicity of glyme-Na[TFSA] mixtures as a function of the salt concentration at 30 ºC and Walden plot are shown in **Figures S3** and **S4**, respectively. The charge and discharge curves for the $[Na \mid [Na(G5)_1][TFSA] \mid Na_{0.44}MnO_2]$ cell at 30 °C are also attached in **Figure S5**.

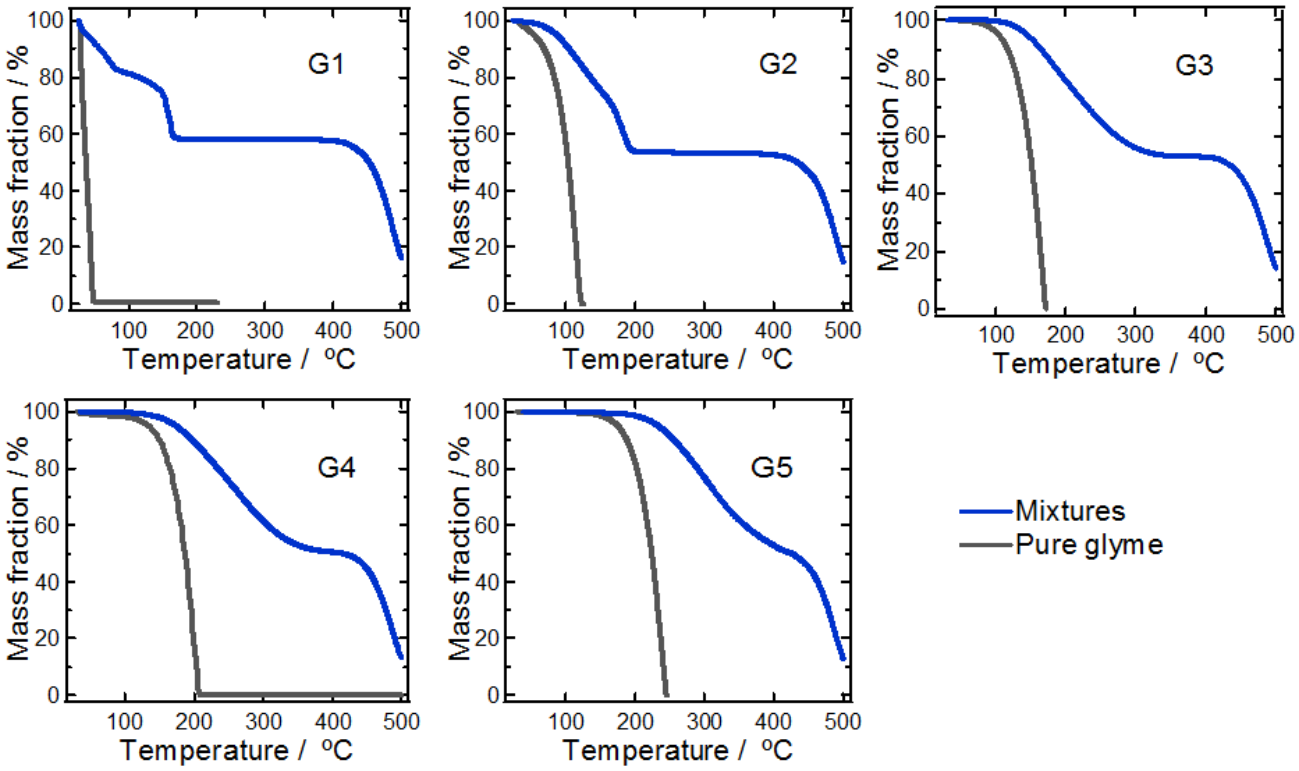


**Figure S1**. Temperature-dependent TG curves for a series of glyme-Na[TFSA] binary mixtures with a fixed [O]/[$Na^+$] ratio of 6. The curves for the corresponding pure glymes are also shown.

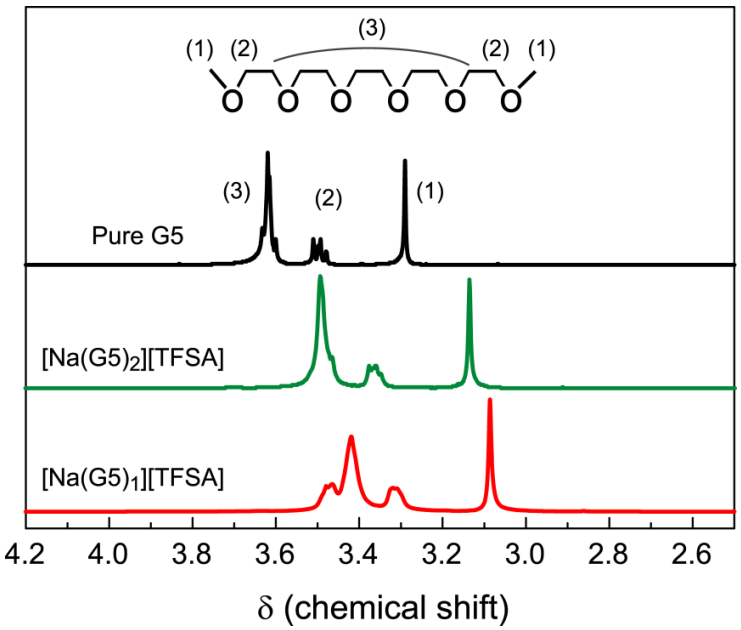


**Figure S2.** $^{1}$H NMR (400 MHz, $CDCl_3$) spectra for G5, $[Na(G5)_1][TFSA]$, and $[Na(G5)_2][TFSA]$ at 30 °C. Chemical shift assignment is also shown for the chemical structure.

**Table S1**. Viscosity ($\eta$), density ($\rho$), molar concentration ($c$), ionic conductivity ($\sigma$), and ionicity ($\Lambda_{imp}/\Lambda_{ideal}$) of G5–Na[TFSA] binary mixtures at 30 °C.

| | $\eta$ (mPa s) | $\rho$ (g cm$^{-3}$) | $c$ (mol dm$^{-3}$) | $\sigma$ (mS cm$^{-1}$) | $\Lambda_{imp}/\Lambda_{ideal}$ |
|---|---|---|---|---|---|
| $[Na(G5)_{0.8}][TFSA]$ | 1466 | 1.44 | 2.79 | 0.120 | 0.63 |
| $[Na(G5)_{0.9}][TFSA]$ | 685 | 1.41 | 2.60 | 0.239 | 0.63 |
| $[Na(G5)_{1}][TFSA]$ | 244 | 1.39 | 2.44 | 0.609 | 0.63 |
| $[Na(G5)_{1.25}][TFSA]$ | 107 | 1.34 | 2.11 | 1.02 | 0.52 |
| $[Na(G5)_{2.02}][TFSA]$ | 33.6 | 1.26 | 1.49 | 1.82 | 0.41 |
| $[Na(G5)_{3.33}][TFSA]$ | 16.1 | 1.19 | 1.00 | 2.13 | 0.35 |
| $[Na(G5)_{7.17}][TFSA]$ | 8.15 | 1.10 | 0.50 | 1.72 | 0.28 |
| $[Na(G5)_{38.0}][TFSA]$ | 5.15 | 1.04 | 0.10 | 0.318 | 0.16 |
| $[Na(G5)_{76.4}][TFSA]$ | 4.86 | 1.03 | 0.05 | 0.143 | 0.14 |
| $[Na(G5)_{384}][TFSA]$ | 4.64 | 1.02 | 0.01 | 0.0267 | 0.12 |
| $[Na(G5)_{768}][TFSA]$ | 4.60 | 1.02 | 0.005 | 0.0131 | 0.12 |
| $[Na(G5)_{3840}][TFSA]$ | 4.58 | 1.02 | 0.001 | 0.00436 | 0.20 |
| $[Na(G5)_{7690}][TFSA]$ | 4.58 | 1.02 | 0.0005 | 0.00269 | 0.25 |
| $[Na(G5)_{38400}][TFSA]$ | 4.57 | 1.02 | 0.0001 | 0.000855 | 0.39 |

**Table S2**. Viscosity ($\eta$), density ($\rho$), molar concentration ($c$), ionic conductivity ($\sigma$), and ionicity ($\Lambda_{imp}/\Lambda_{ideal}$) of $[Na(G5)_1][TFSA]$ at 60 °C.

| | $\eta$ (mPa s) | $\rho$ (g cm$^{-3}$) | $c$ (mol dm$^{-3}$) | $\sigma$ (mS cm$^{-1}$) | $\Lambda_{imp}/\Lambda_{ideal}$ |
|---|---|---|---|---|---|
| $[Na(G5)_{1}][TFSA]$ | 43.9 | 1.36 | 2.39 | 2.84 | 0.53 |

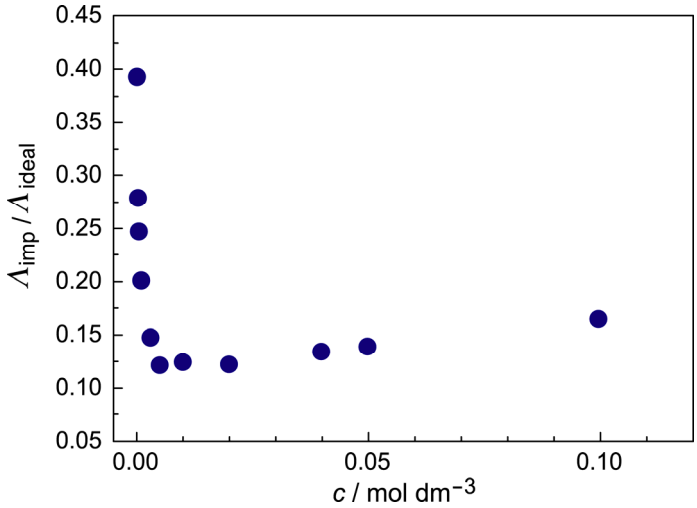


**Figure S3.** Ionicity ($\Lambda_{imp}/\Lambda_{ideal}$) of [Na(G5)$_x$][TFSA] as a function of the salt (Na[TFSA]) concentration $c$ in the range of 0.0001–0.1 mol dm$^{-3}$ at 30 °C.

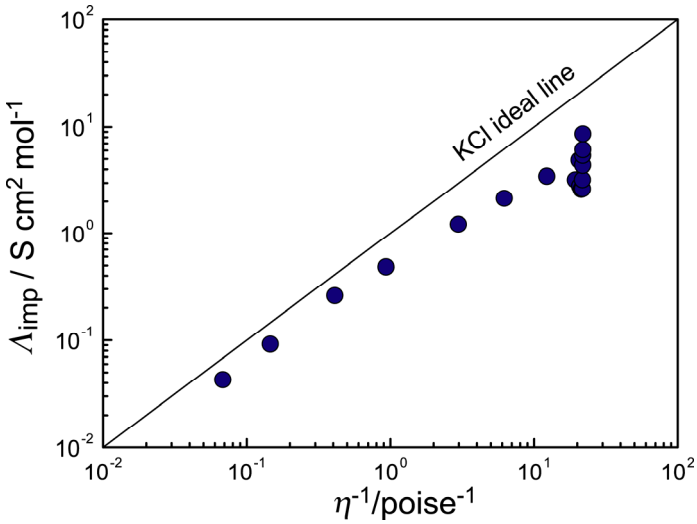


**Figure S4.** Walden plot for G5–Na[TFSA] mixtures at 30 °C based on the data in Table S1.

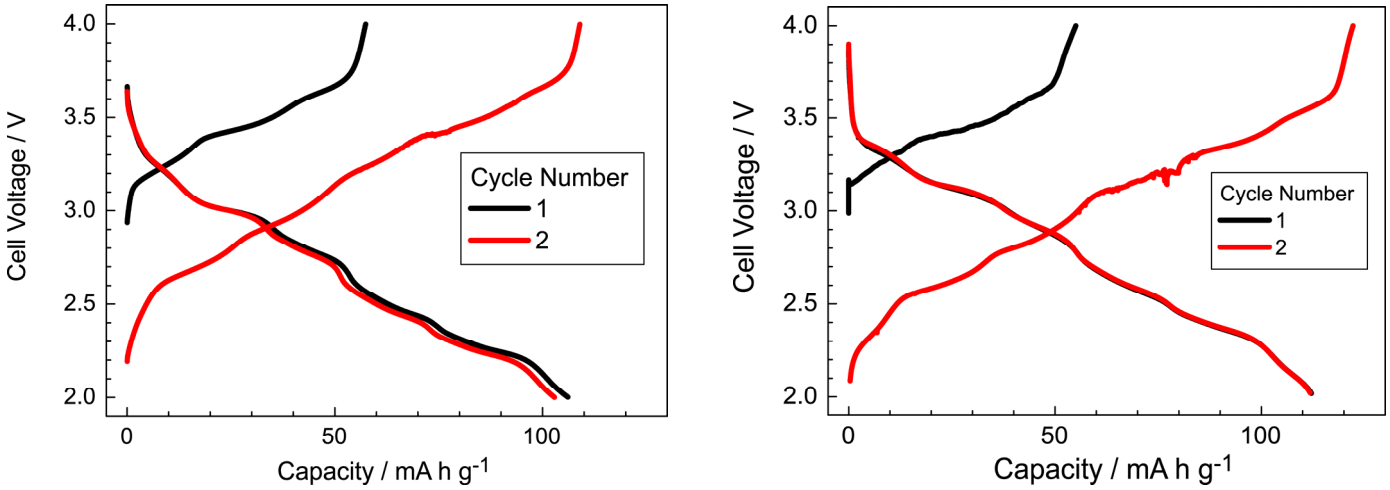


**Figure S5.** The charge–discharge curves for the [Na | [Na(G5)$_1$][TFSA] | $Na_{0.44}MnO_2$] cell measured at 30 °C at current densities of 40 (left) and 10 (right) μA cm$^{-2}$ (12.15 and 1.94 mA g$^{-1}$ based on the mass of $Na_{0.44}MnO_2$).