DES- and IL-based liquid and (hybrid) solid electrolytes for SIBs

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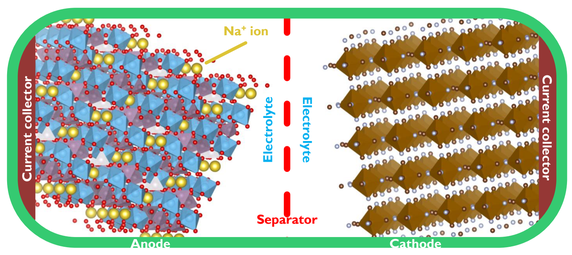
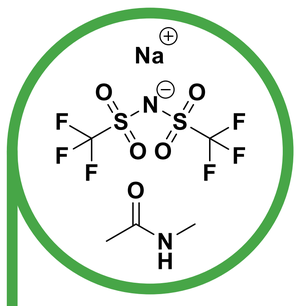
Na — cost Na_2CO_3 218 EUR ton^{-1} — Earth's crust 2.6% — Evenly spread across Earth

Development of safe, nonflammable liquid and solid (hybrid) electrolytes for sustainable SIBs



Na-DES based electrolytes

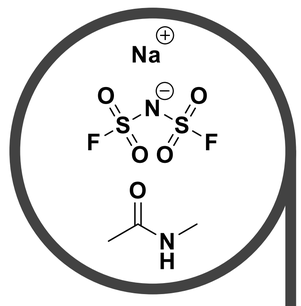


Ionic conductivity (20 °C)

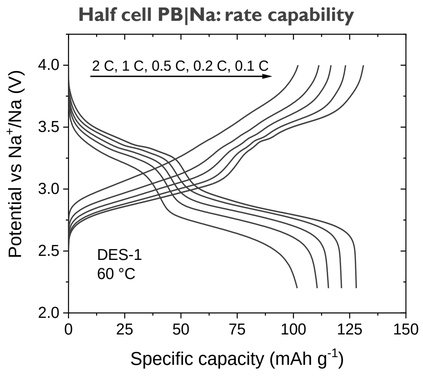
0.355-3.05 mS cm^{-1} **0.0561-6.58**

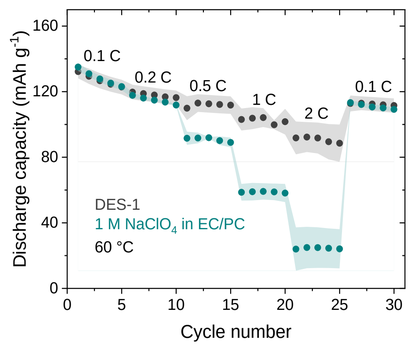
Anodic stability (vs Na$^+$/Na)

Up to 4.65 V **Up to 4.0**



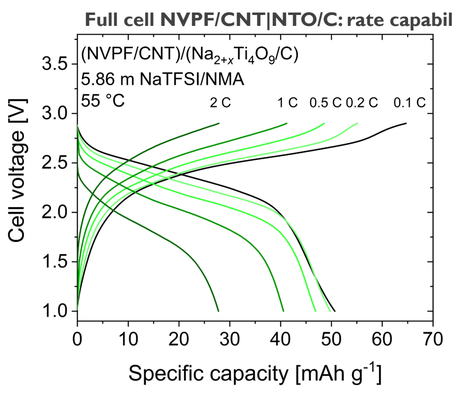
Half cell PB|Na: rate capability

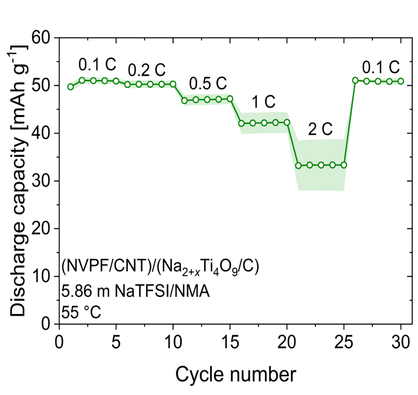




More info: "Superconcentration strategy allows sodium metal compatibility in deep eutectic solvents for sodium-ion batteries" DOI 10.1021/acsomega.4c02896.

Full cell NVPF/CNT|NTO/C: rate capability

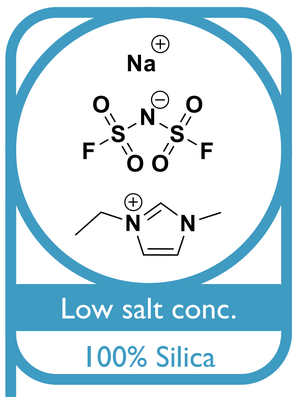




More info: De Sloovere, et al. (2022). Deep eutectic solvents as nonflammable electrolytes for durable sodium-ion batteries. *Advanced Energy and Sustainability Research*, *3*(3), 2100159.

Na-ionogels

Ionogel: confinement of ionic liquid electrolyte (ILE) in a silica matrix



Low salt conc.
100% Silica

Ionic conductivity (20 °C)

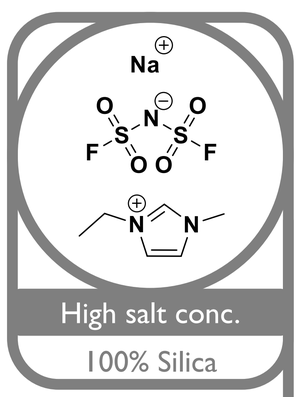
2.4-5.5 mS cm^{-1} **2.6-4.3**

Anodic stability (vs Na$^+$/Na)

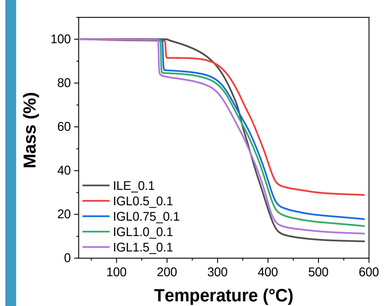
~5.2 V **~5.4**

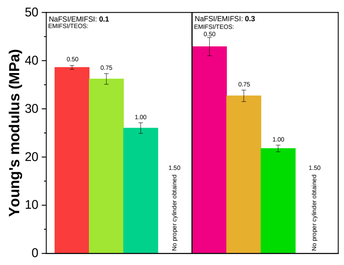
Cathodic stability (vs Na$^+$/Na)

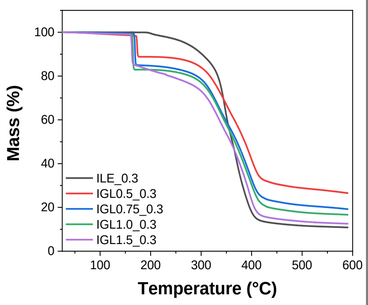
~0.4 V **~-0.1**

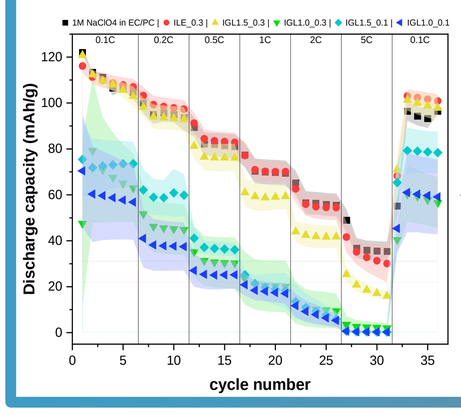


High salt conc.
100% Silica





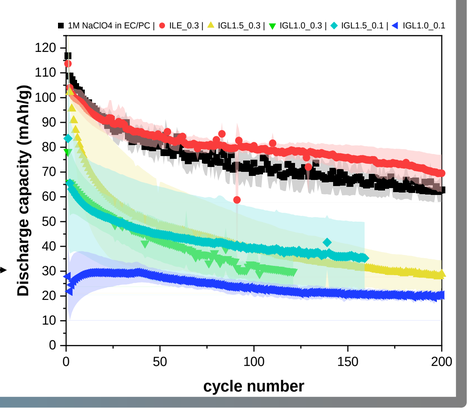




Half cell NTP/C|Na

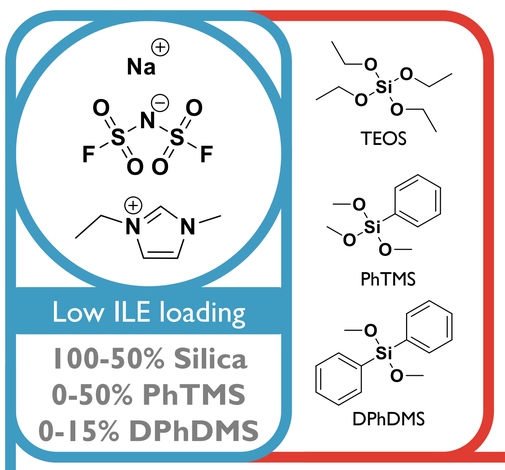
Rate capability

Cycle life (0.2C)



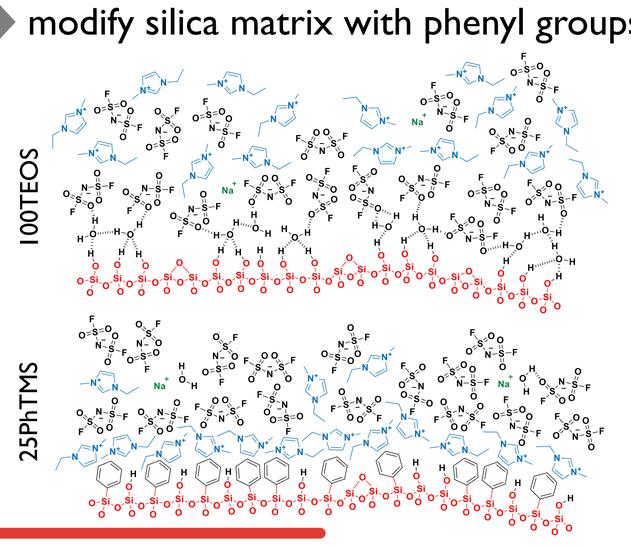
Organically modified Na-ionogels

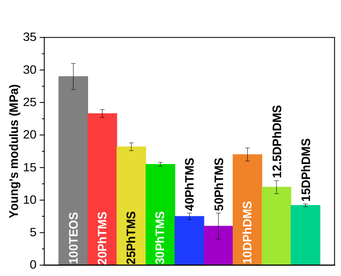
Silica-based ionogels: brittle ➡ modify silica matrix with phenyl groups

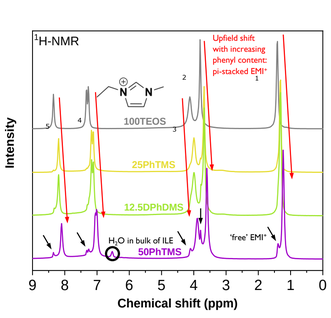


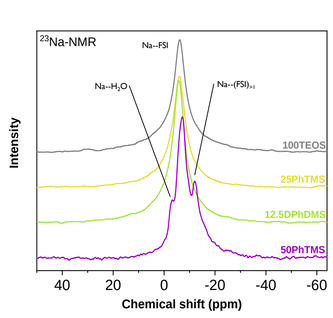
Low ILE loading
100-50% Silica
0-50% PhTMS
0-15% DPhDMS

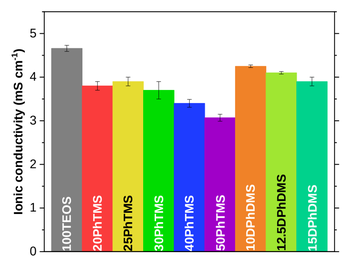
TEOS
PhTMS
DPhDMS

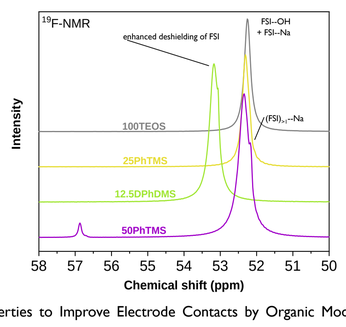


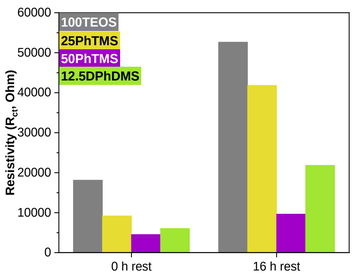








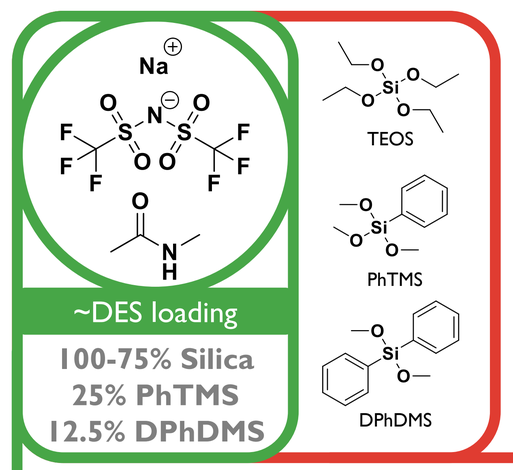




More info: Mercken, J. *et al.*, (2023). Altering Mechanical Properties to Improve Electrode Contacts by Organic Modification of Silica-Based Ionogel Electrolytes for Sodium-Ion Batteries. *Small*, *19*(40), 2301862.

Organically modified Na-eutectogels

Eutectogel: confinement of deep eutectic solvent (DES) in silica matrix



~DES loading
100-75% Silica
25% PhTMS
12.5% DPhDMS

TEOS
PhTMS
DPhDMS

Anodic stability (vs Na$^+$/Na)

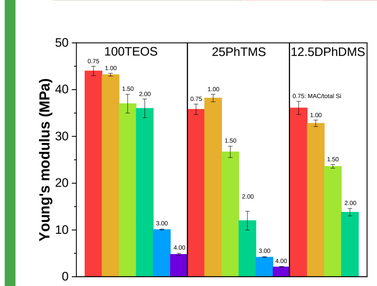
Up to 4.74 V

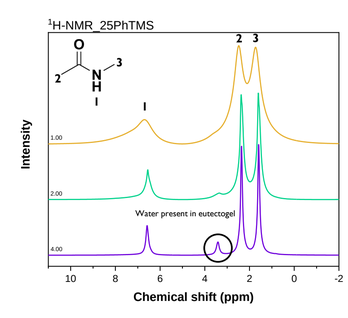
Cathodic stability (vs Na$^+$/Na)

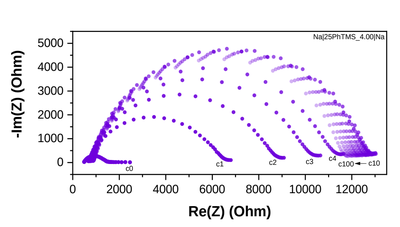
As low as 0.81 V

Thermal stability

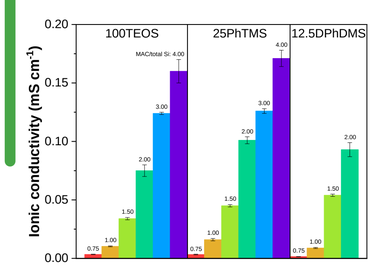
Up to 128 °C

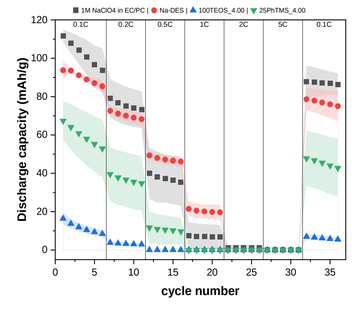






Not stable against Na metal





Full cell PB|NTP/C

Rate capability

Preliminary results

www.uhasselt.be/imo-imomec