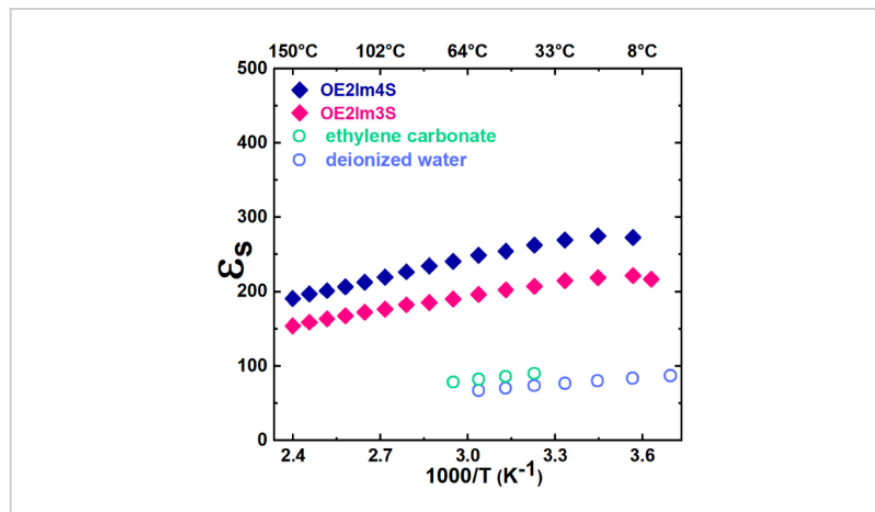


# Synthesis of High Dielectric Constant Zwitterionic Liquids

ID# 2021-5360



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Temperature dependence of the dielectric constant of zwitterionic liquids.

## Technology Summary

Zwitterions have a cation and an anion connected via a linker bridge that coexist as one molecule. Most zwitterions do not show large dielectric constants, because they are crystalline at ambient temperature and the molecular dipole limits the ring-opening reaction chemistry. The inventors have created a novel class of zwitterion compositions with exceptionally high  $\epsilon_s$  from -20 to 120 °C. A two-step synthesis results in high purity zwitterions that form liquids at ambient temperatures with a low glass transition temperature allowing for facile tailoring of cation-anion linkage lengths, which influences the dielectric constant. These high yield materials inhibit crystallization, which promotes homogeneous dispersion with soft materials. The inventors also have sterically shielded the cation and used charge-delocalized anions to increase molecular mobility and lower the melting point.

## Application & Market Utility

High dielectric constant ( $\epsilon_s$ ) soft materials have applications for soft robotics, actuators, batteries and capacitors. A conventional mode of improvement combines materials with high  $\epsilon_s$  such as inorganic fillers and polar organic solvents with the host materials having a lower dielectric constant. However, inorganic fillers suffer from poor miscibility with polar liquids, which are often volatile and flammable. Additional constraints include controlling the resulting material's conductivity, which can result in breakdown at too low voltage.

## Next Steps

Potential commercial utility includes energy-related applications, such as non-volatile solid-state electrolytes for batteries, low-voltage actuators, and high-energy-density capacitors. Evaluation samples may be available.

TECHNOLOGY READINESS LEVEL

4

### Seeking

#### Keywords

- Ultra-high Dielectric Materials
- Capacitors
- Artificial Muscles
- Zwitterion
- Lithium-ion battery

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