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A Safer, Wide-Temperature Liquefied Gas Electrolyte Based on Difluoromethane

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HIGHLIGHTS

- Demonstration of unique safety feature inherent to liquefied gas electrolytes.
- Low flammability, difluoromethane based solvent enables wide temperature operation.
- Raman spectroscopy reveals few free co-solvent molecules and high salt aggregation.
- MD simulations compliment experimental results with insight into Li^+ transportation.
- Li.|Cu plating/stripping and full cells operational through a wide temperature range

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ABSTRACT

Development of safe electrolytes that are compatible with both lithium metal anodes and high-voltage cathodes that can operate in a wide-temperature range is a formidable, yet important challenge. Recently, a new class of electrolytes based on liquefied gas solvents has shown promise in addressing this issue. Concerns, however, have been raised on the pressure, flammability and low maximum operating temperature of these systems. Here, we endeavor to mitigate safety and practicality concerns by demonstrating an enhanced safety feature inherent in liquefied gas electrolytes and by showing the viability of using difluoromethane as a liquefied gas solvent which has lower pressure, lower flammability, and improved maximum operation temperature characteristics compared with fluoromethane. We create a custom-built setup to enable liquefied gas electrolyte characterization through Raman spectroscopy and supplement this with molecular dynamics (MD) simulations. The electrolyte shows good conductivity through a wide temperature range and compatibility with both the lithium metal anode and 4 V class cathodes. The demonstrated use of such alternative liquefied gas solvents opens a path towards the further development of high-energy and safe batteries that can operate in a wide-temperature range.

1. Introduction

Batteries are ubiquitous today in a vast number of applications. They vary greatly in size and application, from portable electronics to providing energy storage for grid reliability and resiliency. The front running chemistry for a number of these applications is the

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