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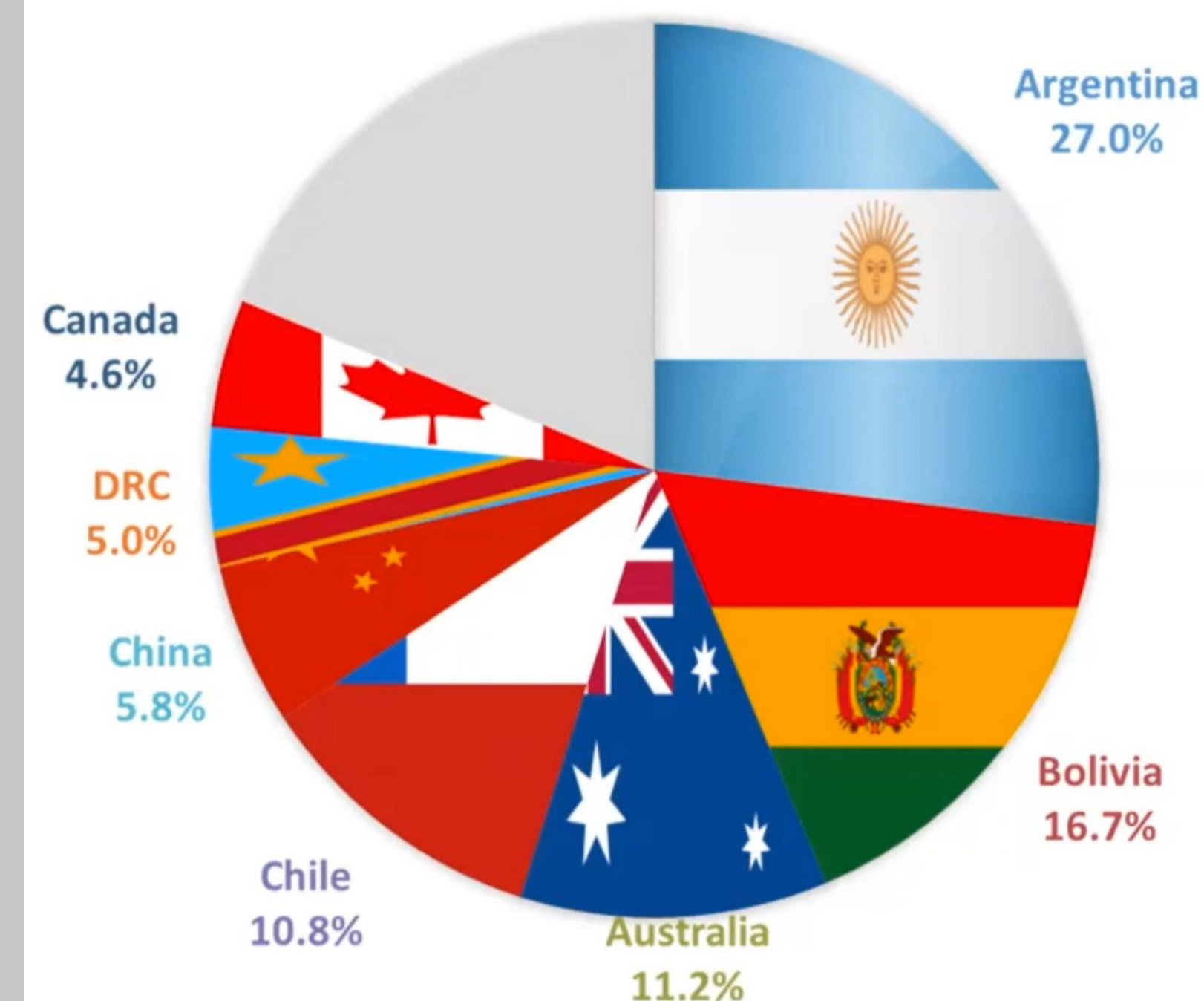
Potential Transformative Energy Storage

The Promise of Magnesium-Ion Batteries

- 8th most abundant element
- Low-cost raw material
- Higher energy density
- High volumetric capacity
- Safer
- Multivalent Ion



Global Lithium Resources

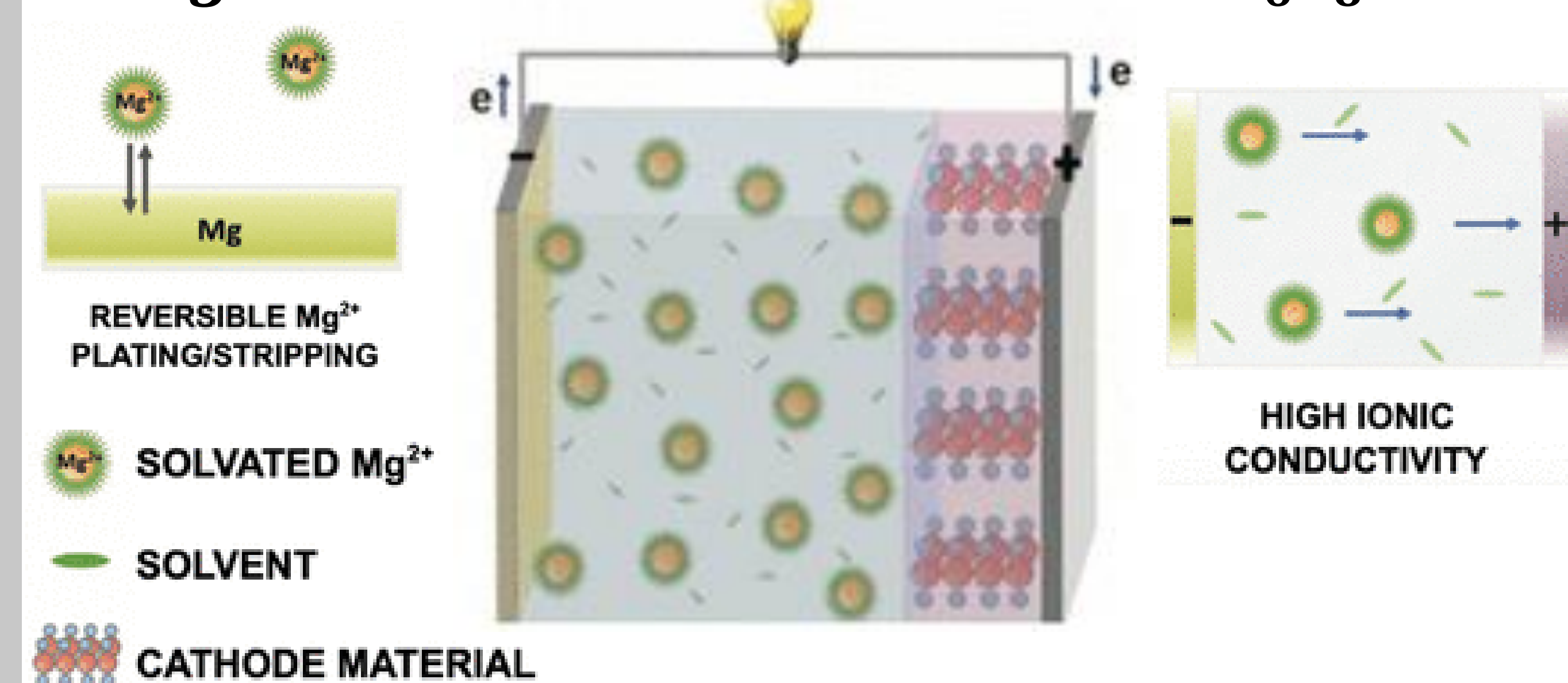


• Argentina + Bolivia own > 43% of global Lithium

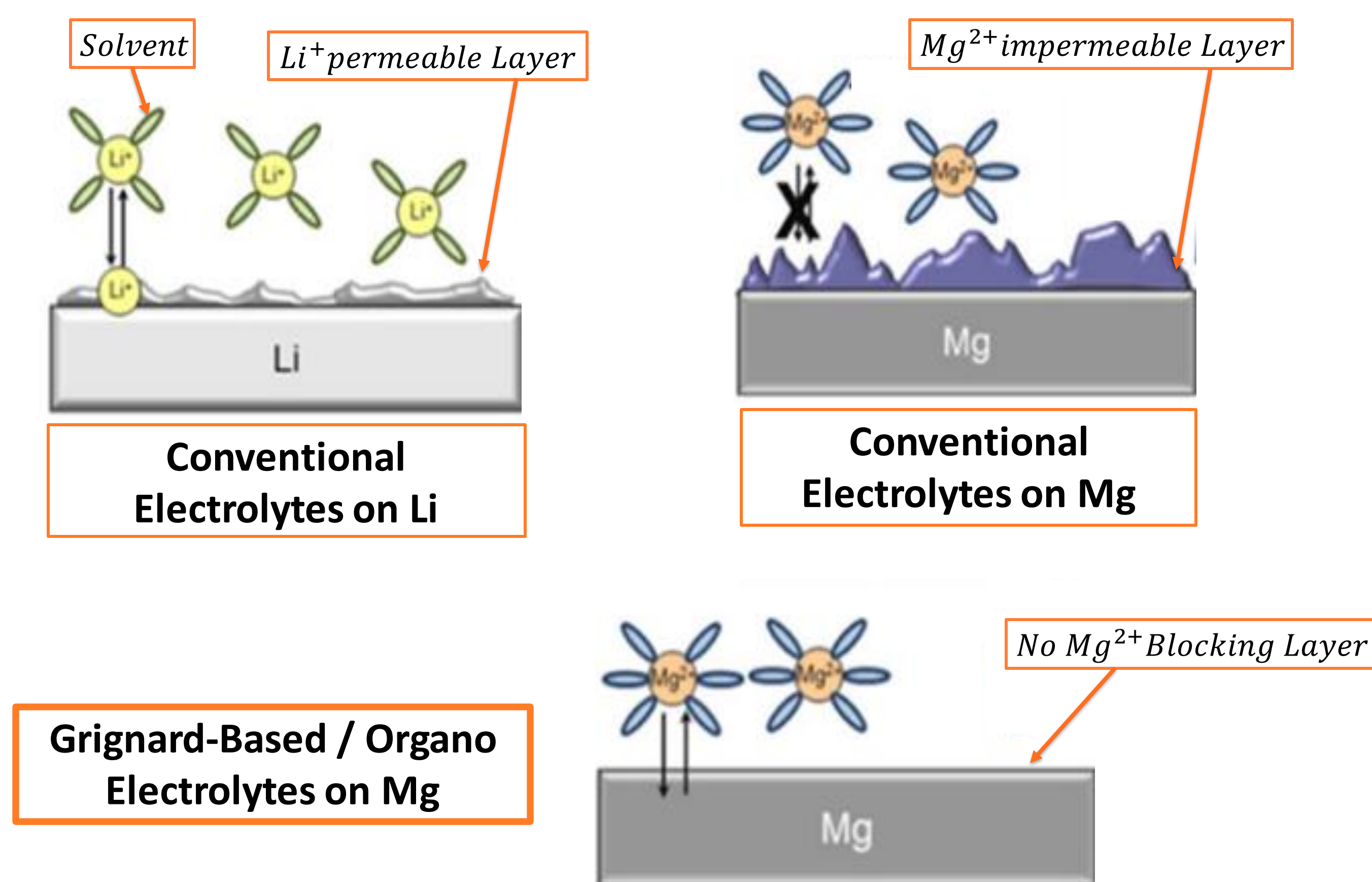
• Top 7 countries own >80% of global Lithium resources!

Multivalent: Similar to Li-ion

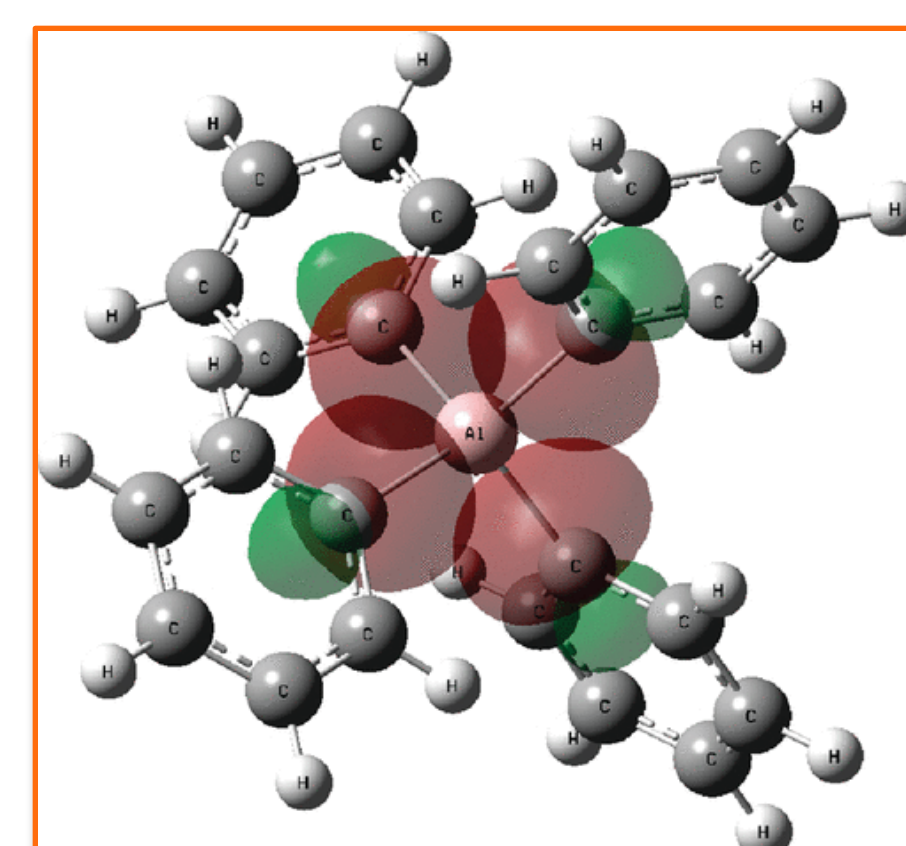
- Volumetric Energy Density:
 $Li \sim 2062 \text{ mAhcm}^{-3}$
 $Mg \sim 3832 \text{ mAhcm}^{-3}$
- Anode: Mg Metal
- Cathode: Chevrel Phase Mo_6S_8



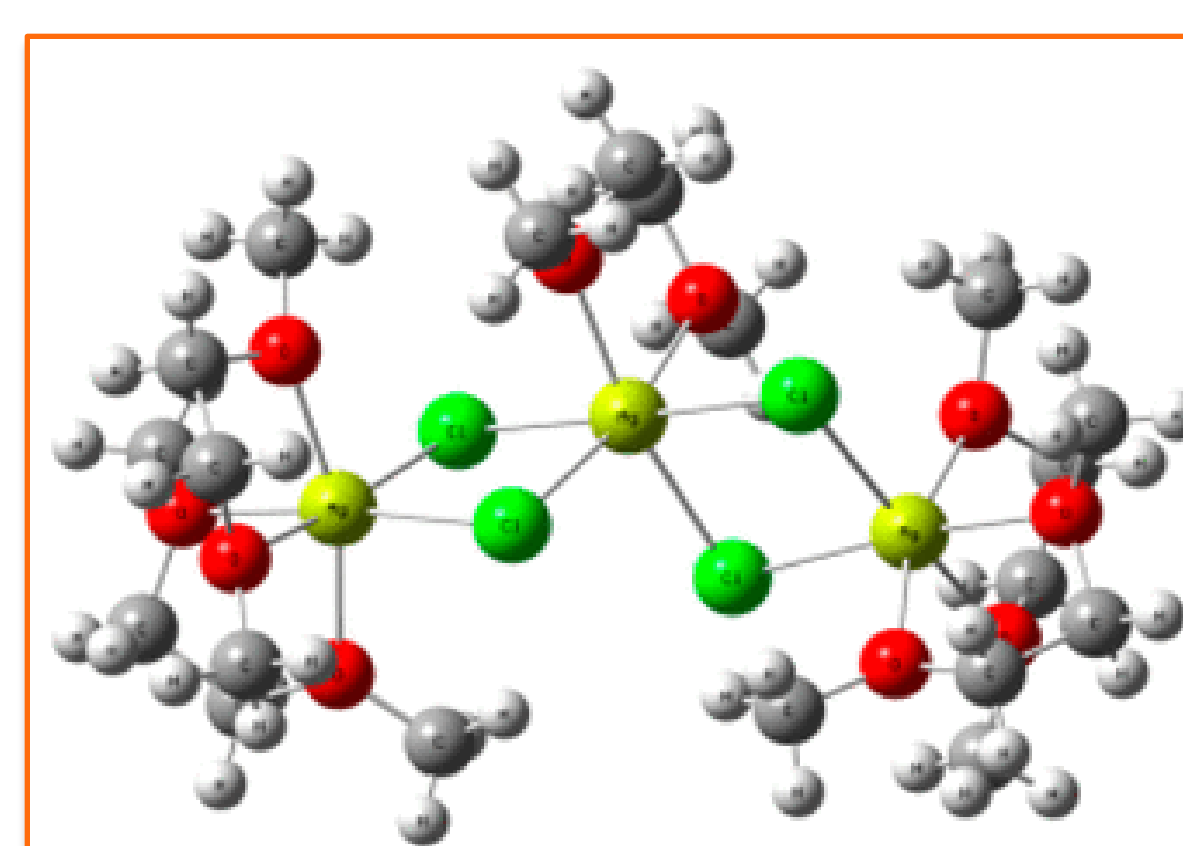
Magnesium-Ion Electrolytes



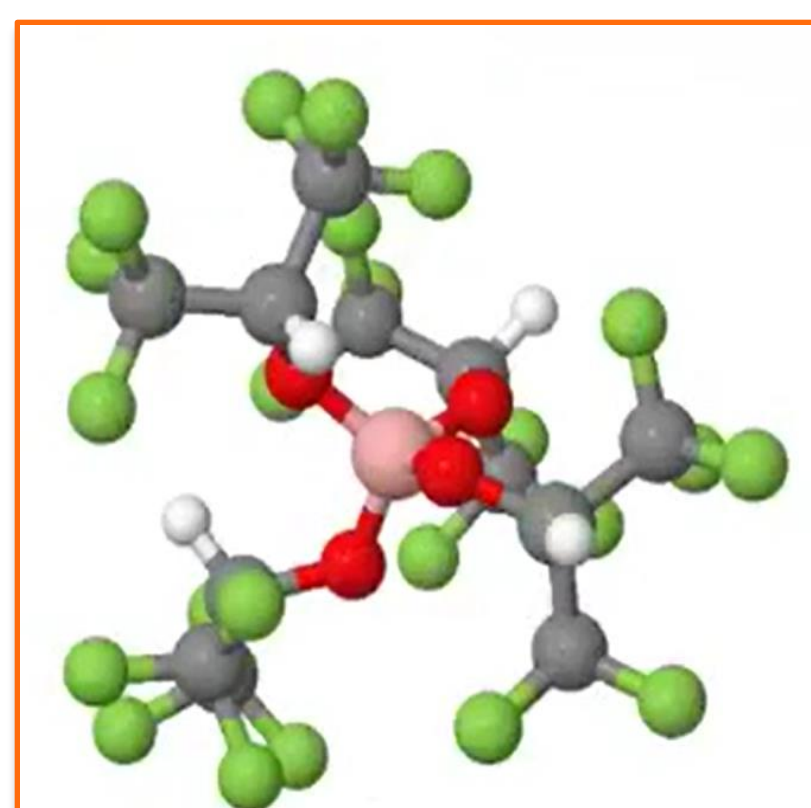
Promising Mg-Ion Electrolytes



Grignard-Based: All-Phenyl Complex (APC)



Chlorine-Based non-nucleophilic: $Mg(TFSI)_2/MgCl_2$

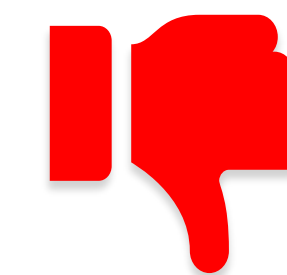


Chlorine-free, non-corrosive:
 $Mg[B(HFIP)_4]_2$ and $Mg[Al(HFIP)_4]_2$

Drawbacks: APC and Cl based Electrolytes

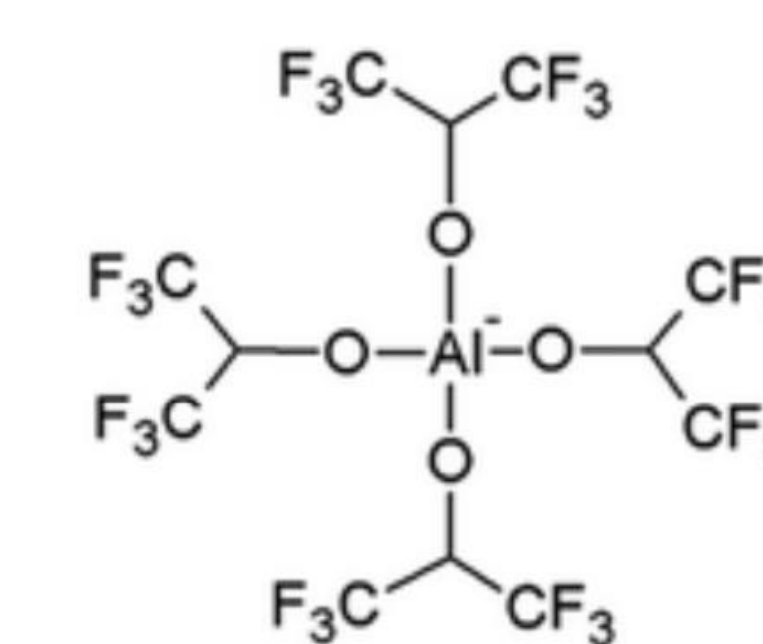


- Support plating/stripping of Magnesium

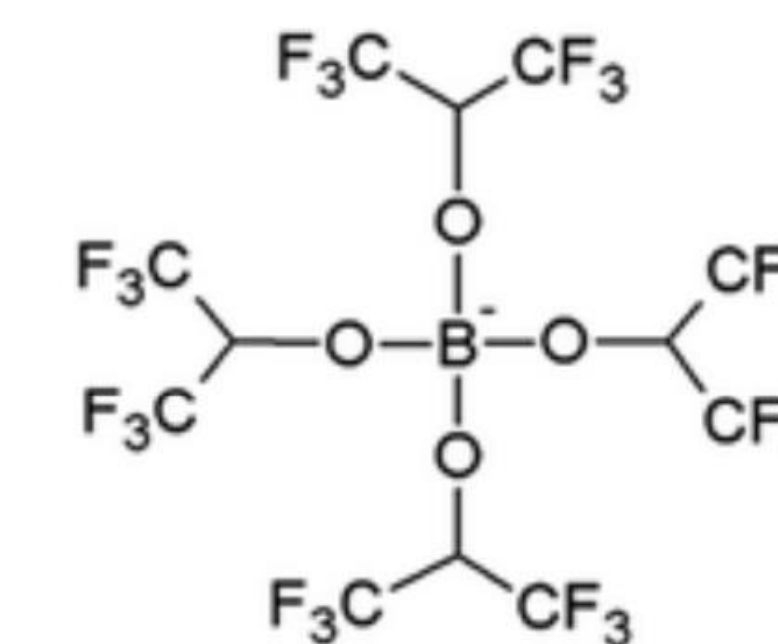


- High Corrosivity
- Insufficient Anodic Stability
- Incompatible with typical cathodes
- Moisture Sensitive
- All extremely hinder practical battery materialization

Towards Cl-free Electrolytes

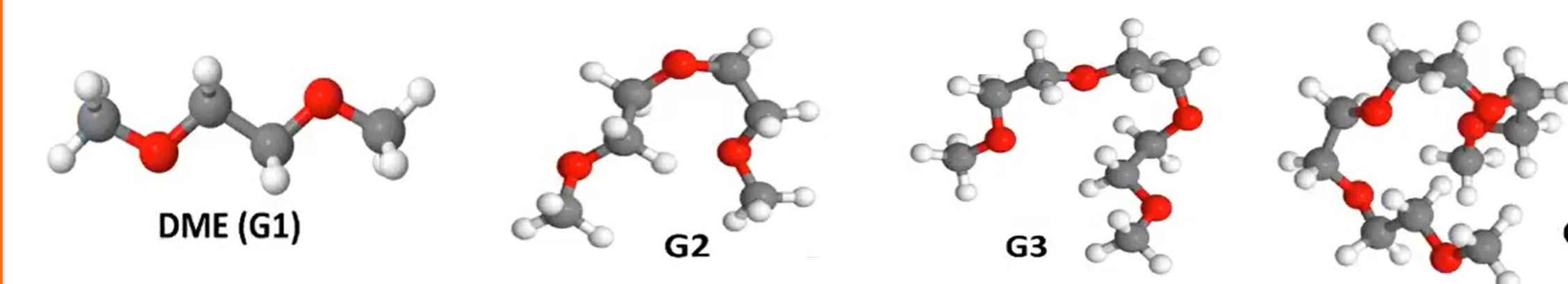


Magnesium Fluorinated Alkoxyaluminate
 $Mg[Al(HFIP)_4]_2$

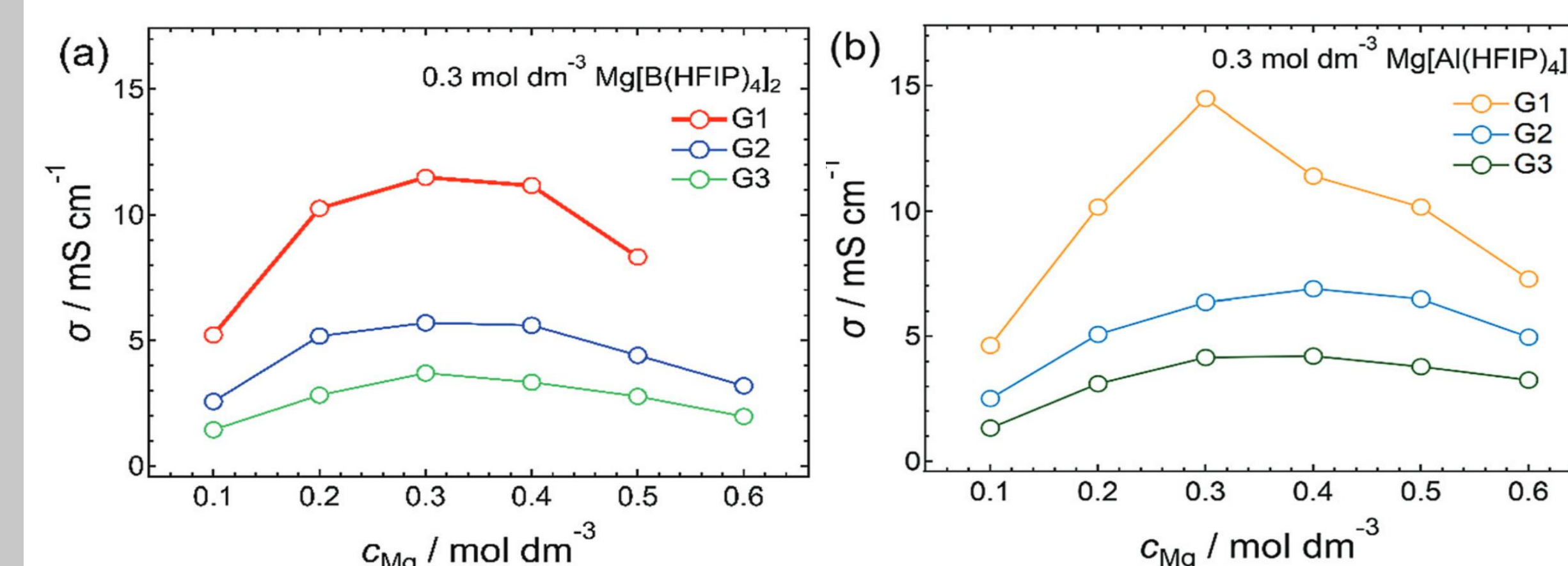


Magnesium Fluorinated Alkoxyborate
 $Mg[B(HFIP)_4]_2$

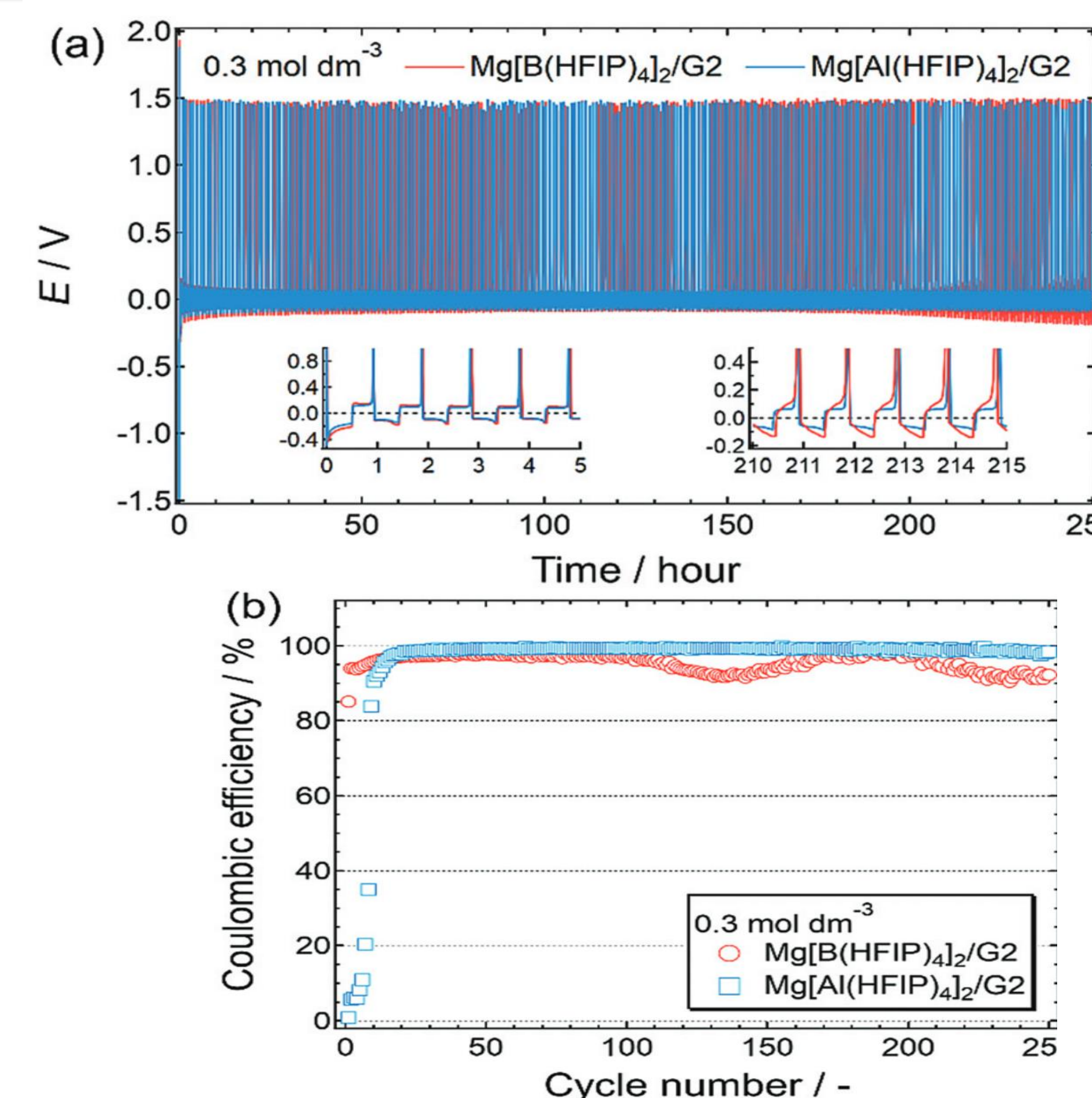
Solvents for Mg Electrolytes



Physicochemical Properties



Electrochemical Characteristics



References:
 Jake T. Herb, Carl A. Nist-Lund, and Craig B. Arnold, ACS Energy Letters 2016 1 (6), 1227-1232
 DOI: 10.1021/acseenergylett.6b00356
 Zhao-Karger, Z.; Gil-Banet, M. E.; Fuhr, O.; Fichtner, M. A New Class of Non-Corrosive, Highly Efficient Electrolytes for Rechargeable Magnesium Batteries. Journal of Materials Chemistry A 2017, 5 (22), 10815-10820
 DOI: 10.1039/c7ta02237a
 Mandal, T.; Yoon, Y.; Tateyama, Y. Remarkable Electrochemical and Ion-Transport Characteristics of Magnesium-Fluorinated Alkoxyaluminate-Diglyme Electrolytes for Magnesium Batteries. Materials Advances 2021, 2 (19), 6283-6296.
 DOI: 10.1039/d1ma00448d