Phosphonium-based ionic liquids for high capacity lithium batteries

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The commercial progress of high-capacity anodes such as lithium metal and silicon has stalled due to the inability to prevent dendrite growth and mitigate the destructive effects of volume expansion. High salt concentration electrolytes have recently been shown to prevent the breakdown of organic solvent species at the electrode and instead promote desirable SEI-forming compounds such as LiF.[1] Substituting the organic solvent with an ionic liquid has also been a well-studied strategy that offers further advantages in device safety while opening up a new raft of custom electrolyte chemistries. Symmetric perfluorinated anions such as bis(flurosulfonyl)imide (FSI) and bis(trifluoromethanesulfonyl)imide (TFSI) have been identified as promising anions due to their SEI-forming properties, while small tetraalkylphosphonium cations have emerged as the benchmark choice of cation owing to improved electrochemical stability and fluidity. Recent work within our group has focused on implementing the high salt concentration approach in phosphonium-FSI ionic liquid electrolytes using high-capacity lithium and silicon electrodes.[2-5] In these works, we have achieved several notable results including stable Li metal cycling of up to 12 mA/cm^2, 6 mAh/cm^2 at 50 ^oC, and 3000 mAh/g_{Si} for 300 cycles (C/2.5) at room temperature. These studies have shown that the electrode surface deposit is dense, compact, and can also provide substantial tolerance of the electrode towards H_2O which may be of great benefit for Li-Air devices. Translation of these promising results is being carried out at the Battery Technology Research and Innovation Hub (BatTRI-Hub) through demonstration in prototype pouch cells.

References:

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