Fire-extinguishing organic electrolytes for safe batteries

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Severe safety concerns are currently impeding the large-scale employment of lithium/sodium batteries. Conventional electrolytes are highly flammable and volatile, which may cause catastrophic fires or explosions. Efforts to introduce flame-retardant solvents into the electrolytes have generally resulted in compromised battery performance because those solvents do not suitably passivate carbonaceous anodes. Here we report a salt-concentrated electrolyte design to resolve this dilemma via the formation of a robust inorganic passivation film on the anode. We demonstrate that a concentrated electrolyte using a salt and a popular flame-retardant solvent (trimethyl phosphate, TMP), without any additives or soft binders, allows stable charge–discharge cycling of both hard carbon and graphite anodes for more than 1000 cycles (over one year) with negligible degradation (see Figure 1); this performance is comparable or superior to that of conventional flammable carbonate electrolytes. The unusual passivation character of the concentrated electrolyte coupled with its fire-extinguishing property contributes to developing safe and long-lasting batteries, and unlocking the limit toward development of much higher energy-density batteries.

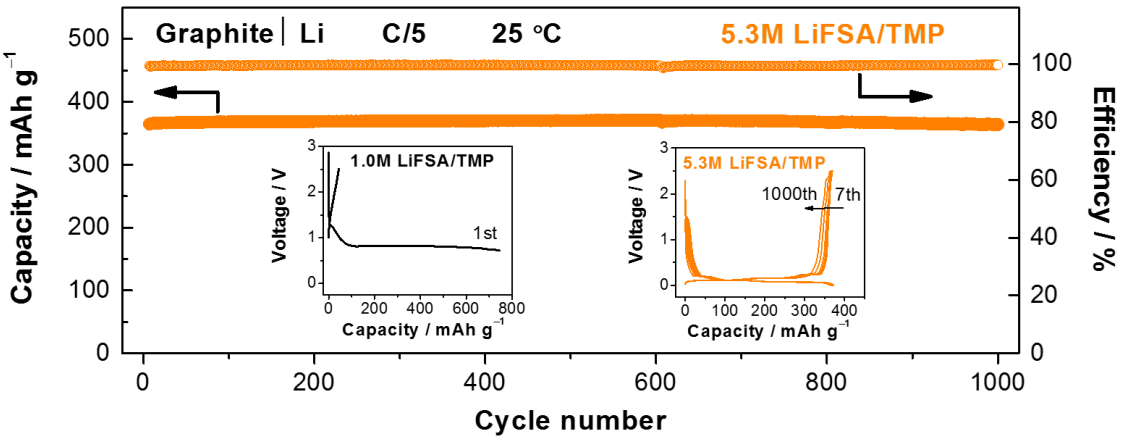

Figure 1. Cycling performance and coulombic efficiency of the natural graphite | lithium metal half-cell using concentrated 5.3 M LiFSA/TMP electrolyte. Insets are selected charge–discharge voltage curves using dilute and concentrated LiFSA/TMP electrolytes, respectively. A 1C-rate corresponds to 372 mA g^{-1} on the weight basis of the graphite active material. The 1000 cycles correspond to a running time of over 13 months.

Reference:

[1] J. Wang, Y. Yamada, K. Sodeyama, E. Watanabe, K. Takada, Y. Tateyama, and A. Yamada, *Nature Energy*, 3, 22-29 (2018),