3D fiber-network reinforced bicontinuous composite solid electrolyte for dendrite-free lithium metal batteries

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Replacement of flammable organic liquid electrolytes with solid Li^+ conductors is a promising approach to realize excellent performance of Li metal batteries.[1-2] However, ceramic electrolytes are either easily reduced by Li metal or penetrated by Li dendrites through their grain boundaries, and polymer electrolytes are also faced with instability on the electrode/electrolyte interface and weak mechanical property. Here we report a 3D fiber-network reinforced bicontinuous solid composite electrolyte with flexible Li^+-conductive network (lithium aluminum titanium phosphate (LATP)/polyacrylonitrile (PAN)), which helps to enhance electrochemical stability on the electrode/electrolyte interface by isolating Li and LATP, and suppress Li dendrites growth by mechanical reinforcement of fiber-network for the composite solid electrolyte. The composite electrolyte shows an excellent electrochemical stability after 15 days contact with Li metal and has an enlarged tensile strength compared to the pure poly(ethylene oxide) (PEO)-(bistrifluoromethanesulfonimide lithium salt) LiTFSI electrolyte, leading to a long-term stability and safety of the Li symmetric battery with a current density of 0.3 mA cm^{-2} for 400 h. In addition, the composite electrolyte also shows good electrochemical and thermal stability. These results provide such fiber-reinforced membranes that present stable electrode/electrolyte interface and suppress lithium dendrite growth for high-safety all-solid-state Li metal batteries.

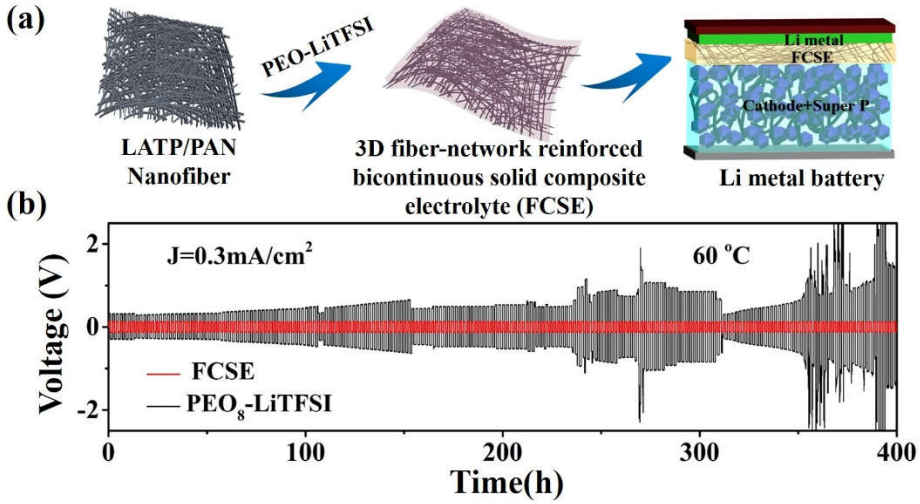

Figure 1: (a) Schematic diagrams of preparation of composite solid electrolyte and model exhibition of solid Li metal battery. (b) Electrochemical compatibility and stability of electrolytes with Li metal.

References:

[1] L. Chen, Y.C. Liu, L.Z. Fan, J. Electrochem. Soc. 164 (2017) A1834-A1840.
[2] D. Li, L. Chen, T.S. Wang, L.Z. Fan, ACS Appl. Mater. Interfaces. In Press.