THE JOURNAL OF PHYSICAL CHEMISTRY C

The Cathode Composition, A Key Player in the Success of Li-Metal Solid-State Batteries

Andrea I. Pitillas Martinez[†], Frédéric Aguesse[†], Laida Otaegui[†], Meike Schneider[‡], Andreas Roters[‡], Anna Llordés[†§], and Lucienne Buannic*[†]

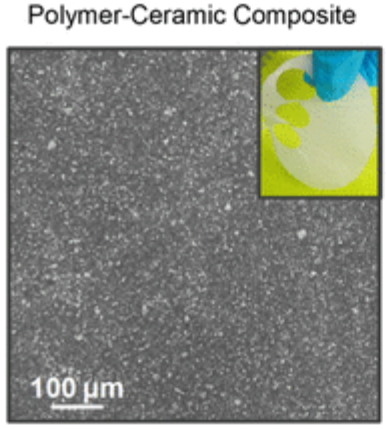
[†] CIC Energigune, Parque Tecnológico de Alava, 01510 Miñano, Spain

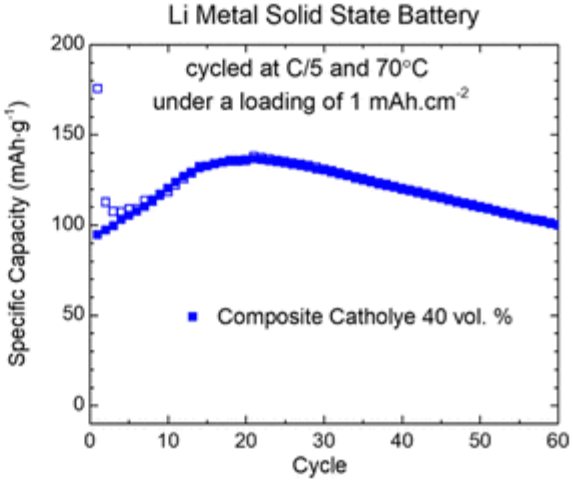
[‡] Schott AG, Hattenbergstraße 10, 55122 Mainz, Germany

[§] IKERBASQUE, The Basque Foundation for Science, Maria Diaz de Haro 3, 48013 Bilbao, Spain

DOI: 10.1021/acs.jpcc.8b04626 Publication Date (Web): February 1, 2019

Abstract





Polymer–ceramic composite electrolytes are major contenders for applications in commercial Li-metal solid-state batteries. However, the cycling performance and energy density of such batteries are not only related to the capabilities of the electrolyte but also to that of the cathode. Here, we investigate the influence of the formulation of a $LiFePO_4$ cathode, paying close attention to the fraction of the catholyte, on the electrochemical performance of a Li-metal solid-state battery and its theoretical energy density. The ionic conductivity and stripping/plating ability of the polymer–ceramic (PEO–LiTFSI–$Li_7La_3Zr_2O_{12}$) composite electrolyte are first evaluated before assessing its C-rate performance and cycle life using a Li-metal anode and a $LiFePO_4$ cathode with a competitive active material loading (≈1 mA h·cm^{-2}). It appears that a fraction of catholyte between 30 and 40 vol % is enough to ensure good interfacial contact and ionic transport throughout the cell. It is estimated that, under certain hypotheses, the cells could provide average energy densities of up to 185 W h·kg^{-1} and 345 W h·L^{-1}, which are well above what are currently reported in the state of the art, because of the high cathode loading targeted in this study. Finally, recommendations for achieving energy density values close to the ones needed for electric vehicle applications (350 W h·kg^{-1} and 750 W h·L^{-1}) are proposed.