Preparation of sphere-like fast ion conductor \( \text{Li}_{0.1}\text{Ce}_x\text{Ca}_{0.9-x}\text{TiO}_3 \) and its application in solid polymer electrolyte

Wei Xiao\(^1,2\), Chang Miao\(^1\), Xinhai Li\(^2\), Zhixing Wang\(^2\), Huajun Guo\(^2\), Mingru Su\(^2\), Yan Li\(^2\)

\(^1\)College of Chemistry and Environmental Engineering, Yangtze University, Jingzhou, 434300, P. R. China
\(^2\)School of Metallurgy and Environment, Central South University, Changsha, 410083, P. R. China

Correspond to xwylyq2009@gmail.com

Abstract: \( \text{Li}_{0.1}\text{Ce}_x\text{Ca}_{0.9-x}\text{TiO}_3 \) was prepared by spray-drying combining with sintering processes, and the sphere-like fast ion conductor \( \text{Li}_{0.1}\text{Ce}_0.1\text{Ca}_{0.8}\text{TiO}_3 \) was obtained after being calcined 6 h at 700 °C in air atmosphere, which is successfully confirmed by SEM and XRD analysis. Then the sample was employed to fabricate PVDF-HFP-based solid polymer electrolytes (SPEs) by solid phase method. Physicochemical performance of the SPEs was characterized by SEM, XRD, TG-DSC, EIS and LSV. The results show that the SPE has uniform surface and excellent thermal stability when the weight ratio of \( \text{Li}_{0.1}\text{Ce}_0.1\text{Ca}_{0.8}\text{TiO}_3 \) to PVDF-HFP is up to 1:1, the ionic conductivity at room temperature can be up to 0.2037 mS cm\(^{-1}\) and the reciprocal temperature dependence of ionic conductivity follows Arrhenius relationship. The interfacial resistance of the Li/SPE/Li simulated cell can rapidly increase to a steady value about 1050 \( \Omega \) cm\(^{-1}\) from the initial value about 650 \( \Omega \) cm\(^{-1}\) during 5 days storage at 30 °C, and the polymer electrolyte can be stable at 5.5 V (vs Li/Li\(^+\)) at room temperature with high lithium ion transference number about 0.3643. When the SPE is used as an electrolyte material for lithium ion battery, the cell presents excellent rate and cyclic performance. It is found that the Li/SPE/LiCoO\(_2\) cell can display high rate capacity about 104.8 mAh g\(^{-1}\) at 1.0 C after 100 cycles. Furthermore, the cell also exhibits good cyclic stability, retaining over 88.35 % of its initial capacity at 2.0 C after 200 cycles, which can be attributed to the improved ionic conductivity at room temperature and lithium ion transference number.