Preparation and electrochemical characterization of Li_2S-P_2S_5-SnS_2 lithium ion conducting glass-ceramics electrolyte

Sangsoo Lee[a], Chanhwi Park[a], Jiyae Do[a] and Dongwook Shin[a*]
[a]Division of Materials Science & Engineering, Hanyang University,
222 Wangsimni-ro, Seongdong-gu, Seoul, 133-791, Korea

E-mail: dwshin@hanyang.ac.kr

In the case of a liquid electrolyte used in conventional lithium ion batteries, there is a main cause of safety problem such as leakage, flame and explosion of lithium ion battery. Therefore, all-solid-state lithium ion batteries (ASSLiBs) are believed to be next generation battery. The safety of ASSLiBs, which is the biggest advantage of ASSLiBs, make it possible to apply as power source for large scale application such as electric vehicle (EV) and an energy storage system (ESS).

Among the solid electrolytes, sulfide based solid electrolytes are one of the best candidate for ASSLiBs because of their high lithium ion conductivity (> 10^{-4} S/cm). In particular, Li_2S-P_2S_5 glass-ceramics electrolytes have several advantages such as low heat treatment temperature, low elastic modulus and single cation conductive along with high ionic conductivity. However, Li_2S-P_2S_5 glass-ceramics solid electrolytes suffer from low electrochemical stability and lack of atmospheric stability.

In this study, we focused on improving the electrochemical stability of Li_2S-P_2S_5 glass-ceramics electrolyte. The mixed glass former effect causes to increase the electrochemical stability in glass system. Therefore, we have substituted SnS_2 for P_2S_5 to take 'mixed glass former effect'. We prepared Li_2S-P_2S_5-SnS_2 glasses and glass-ceramics by using a mechanical milling technique. X-ray diffraction (XRD) and Raman analysis were performed for structural analysis, and electrochemical properties were evaluated. As a result, the electrochemical stability of the Li_2S-P_2S_5-SnS_2 electrolytes were found to be higher than that of the Li_2S-P_2S_5 binary systems.