The Full Cell Design Using Conductive Polymer Coated Selenium Sulfide As a Cathode and Lithiated Silicon As an Anode

Wonhee Kim [a], Seungmin Lee [b], Kwangsup Eom, Hyeong-Jin Kim [a,*]

[a] *Graduate Program of Energy Technology, School of Integrated Technology, Gwangju Institute of Science and Technology, 123 Cheomdangwagi-ro, Buk-gu, Gwangju 61005, South Korea*

[b] *School of Materials Science and Engineering, Institute of Science and Technology, 123 Cheomdangwagi-ro, Buk-gu, Gwangju 61005, South Korea*

E-mail: whkim109@gist.ac.kr, hjkimc@gist.ac.kr

Lithium-Sulfur (Li-S) batteries have been attracted due to high gravimetric capacity of sulfur cathode (1,672 mAh g^{-1}) which is about 10 times more than the commercial metal oxide ($LiCoO_2$:137 mAh g^{-1}). However, the electrode containing sulfur has several challenges with the dissolution of liquid phase polysulfide and the insulating nature of sulfur which cause low loading mass [1]. The lithium anode also cause dendrite formation during cycle.

Herein, we designed the battery using lithiated silicon as an anode and conductive polymer coated selenium sulfide (PANi@SeS_2/C) as a cathode. Selenium sulfide (SeS_2) whose gravimetric capacity is 1,342 $mAhg^{-1}$ take both advantage of sulfur (high capacity) and selenium (high electrical conductivity). Moreover, selenium in SeS_2 was reported to form stable SEI layer of silicon [2]. Conductive polymer (PANi) was coated on the SeS_2/C composite to prevent the dissolution of polysulfide and enhance electrical conductivity. PANi@SeS_2/C composite was synthesized via oxidative polymerization. Lithiated silicon electrode instead of lithium suppress the formation of lithium dendrite.

Conductive polymer enables to reduce polarization from 0.38 V to 0.19 V owing to the conjugation bond in conductive polymer which enhance the conductivity. Hence, the rate capability was improved compared to SeS_2/C composite. In addition, PANi@SeS_2/C composite can load on the electrode up to 2 mg cm^{-2} (**Fig.1**). Rate capability of lithiated silicon -PANi@SeS_2/C full cell was conducted from C/10 to 2C (~2.7 A g^{-1}) (**Fig.2**). It showed 617 mAh/g_{SeS2} at first discharge. The stable electrochemical reaction was shown in constant specific capacity at the same C-rate.

References:

[1] Xiulei Ji et al., *Nature Material* 8 (2009) 500-506

[2] K.S. Eom, J.T. Lee et al., *Nature commun.* 8 (2017) 13888

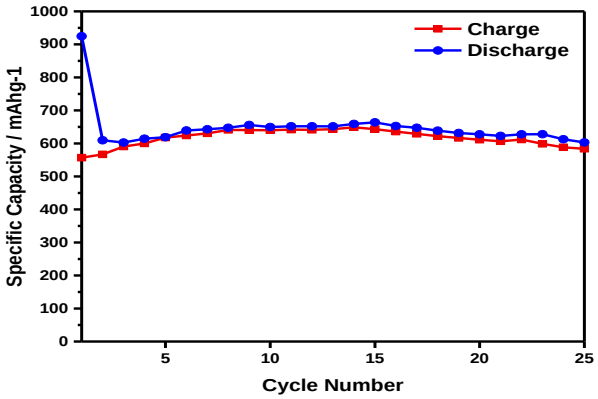

Fig. 1 Li-PANi@SeS_2/C cyclability of SeS_2 with 2 mg loading

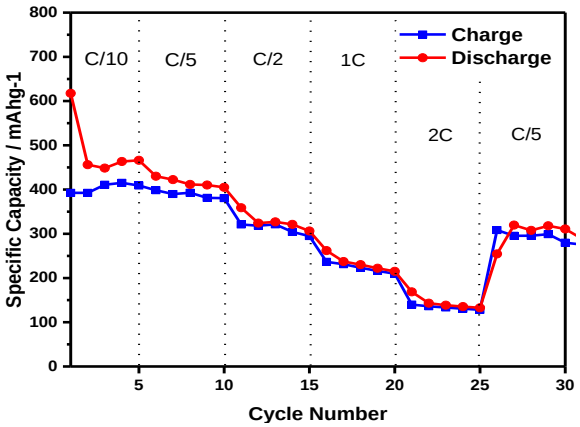

Fig. 2 Lithiated silicon– PANi@SeS_2/C rate capability