Structural change of the discharge products in lithium sulfur battery during storage

Hyungjun Noh [a], Hyunwon Chu [a], Yun-Jung Kim [a], Jinhong Lee [a], Hobeom Kwack [a], Fangmin Ye[a], Hee-Tak Kim[*a]

[a] Department of Chemical and Biomolecular Engineering, Korea Advanced Institute of Science and Technology, 291 Daehak-ro, Yuseong-gu, Daejeon 34141, Republic of Korea

E-mail: hjnoh87@kaist.ac.kr (presenting author)

Lithium-Sulfur (Li-S) battery has been regarded as one of the most promising candidates to commercialize electric vehcles (EVs). Compared to Ni-Cd or commercialized Li ion battery, Li-S battery possesses many advantages, including high theoretical capacity (1,675 mAh/g) and low price of active materials. Energy density, rate capability, and cycling stabilities are regarded as key performances of any next generation secondary batteries, however, memory effect, which is history-dependent variation in battery state, is also a highly important battery chacteristic to be considered. As exampled with Ni-Cd battery, memory effect often leads to an accelerated cell deterioration [1]. In recent years, it was also reported that $LiFePO_4$,which is a promising cathode material for EV applications, has memory effect [2] and it could result in a severe error of battery managment system (BMS). In spite of its importance, such memory effect has not been issued for Li-S battery.

In this work, the structural change of discharge products during storage and its influence on the subsequent cycle was studied. Structural changes with different storage time were clearly observed with ex-situ X-ray diffraction (XRD) and X-ray photoeletron spectroscopy (XPS) analysis. The XRD results demonstrated that the discharge products with a low crystallinity is converted to a more crystalline structure during a storage at room temperature. In addition, the XPS spectra collected at different storage time suggest that the structural change observed in XRD originates from a compositional change of the solid discharge products. The structural evolution of the discharge products significantly influence the overpotential of the subsequent charging step. This small perturbation in voltage profile can induce severe error in battery management system in EVs because it can lead to mis-estimate state of charge. The mechanism for the behavior and the impact on the Li-S performances will be presented and discussed.

References:

[1] Vincent, C. A. & Scrosati, B. Modern Batteries (Elsevier, 1997).
[2] T. Sasaki, Y Uky and P. Novák, Nat. Mater. 12, (2013) 569-575.