



## Effect of electrochemical cycling on microstructure of sulfur electrodes

Assiya Yermukhambetova<sup>1</sup>, Zhazira Berkinova<sup>2</sup>, Boris Golman<sup>1\*</sup>

<sup>1</sup>School of Engineering, Nazarbayev University, Kabanbay batyr av. 53, Astana, Kazakhstan

<sup>2</sup>National Laboratory Astana, Kabanbay batyr av. 53, Astana, Kazakhstan

E-mail: [boris.golman@nu.edu.kz](mailto:boris.golman@nu.edu.kz)

In lithium–sulfur (Li–S) batteries, during discharge, there is a significant morphology change as solid sulfur (S) gets dissolved and undergoes successive reduction and finally precipitates as lithium sulfide (Li<sub>2</sub>S) in porous cathode [1]. This also leads to volume change of the electrolyte in the pore space attributed to precipitation/dissolution of the solid sulfur phase. Moreover, due to the changes in the pore volume coming from the hydrostatic pressure induced by the electrolyte, the cathode microstructure shrinks or swells to accommodate these changes [2]. This leads to mechanical degradation of the electrode over cycling. Thus, the electrochemical performance of lithium sulfur battery is strongly affected by the microstructure of S electrode.

In this work a two-dimensional microstructure of sulfur electrode was examined quantitatively on the basis of the distribution of void sizes (Fig.1), the method of the derivation of the void size distribution is described in [3]. The void and particle size distributions were measured over the virtual slices aligned in the same spatial positions– cross sections of the electrodes at initial and after electrochemical cycling stages obtained in [4] using the image analysis techniques.

It was found that the total voidage has been decreased upon cycling, whereas particle sizes increased. Moreover, the void size distribution became narrow as the number of cycles increased. These changes indicate the pore confinement that leads to reduced transport properties of electrons resulting in lower conductivity of the electrode upon cycling.

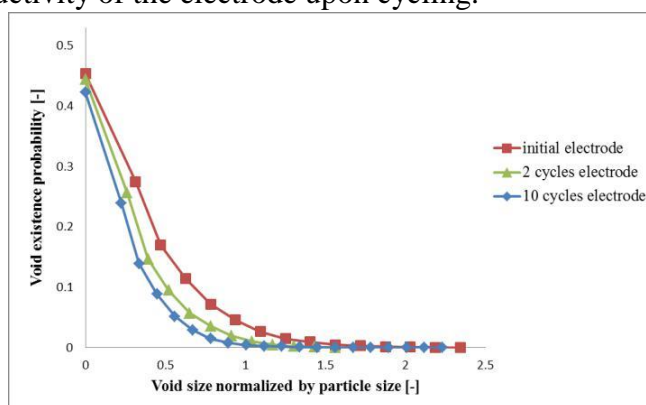


Fig. 11 Void size distribution of S electrodes at initial and after cycling stages

[1] C. Barchasz, F. Mesguich, J. Dijon, J. Leprêtre, S. Patoux, F. Alloin, *J. Power Sources* 211 (2012) 19

[2] J. Nelson, S. Misra, Y. Yang, A. Jackson, Y. Liu, H. Wang, H. Dai, J. C. Andrews, Y. Cui, and M. F. Toney, *J. Am. Chem. Soc.*, vol. 134, no. 14, (2012) 6337–6343

[3] K. Ohzeki, K. Seino, T. Kumagai, B. Golman, K. Shinohara *Carbon* 44 (2006) 578–586

[4] A. Yermukhambetova, C. Tan, S. Daemi, Z. Bakenov, J. Darr, D. Brett, P. Shearing, *Scientific Reports* 6, (2016), 35291

