Materials Panel Abstract & Speaker Biography

Li-S cathode materials: from nano-size effect and polysulfide trapping to *in-situ* wrapping

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As one of the most intensely investigated technologies in the electrochemical energy storage beyond Lithium-ion, lithium-sulfur (Li-S) batteries have observed rapid improvements in their properties in recent years. This presentation reports recent progresses in the understanding and development of Li-S cathode design.

The Li-S technology promises for high specific capacity, however, sulphur materials are usually not fully utilized due to the insulating nature of elementary sulphur and the discharging products Li_2S_2 and Li_2S. We show that there exists significant nano-size effect in cathode S materials, where the conversion reaction is affected by both the particle size and the discharge current density. The theoretical specific capacity of 1670 mAh/g was demonstrated using 5 nm diameter S nanoparticles. [1-3]

Although showing high initial capacity, small nanoparticles are difficult to make, and also facilitates polysulfide shuttling. Thus, we design polysulfide trapping agents for practical applications. An *in-situ* activated free radical cation $PTMA^+$ was exploited as a multifunctional binder to replace the conventional PVDF. It resulted in high capacity, very stable cycling, and good performance under high rate. [4-5]

To further improve cycling stability, another technique, i.e., *in-situ* wrapping was developed to completely block polysulfide leakage. Extremely low capacity fading was observed once the cathode structure reacted with a special additive in the electrolyte to form a compact and tight wrapping layer as the battery operated. This indicates that polysulfide dissolution in electrolyte is actually desirable to give high capacity but needs to be restricted in a smart way to have long cycle life. [6]

References

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Liwei Chen is a Professor of Physical Chemistry at Suzhou Institute of Nanotech and Nanobionics (SINANO), Chinese Academy of Sciences. He received his B. S. from University of Science and Technology of China, M. S. from Peking University, and Ph. D. in Chemistry from Harvard University (Prof. C. M. Lieber). He then worked as postdoctoral research fellow at Columbia University (Prof. L. E. Brus) and taught at Ohio University as an assistant professor from 2004 - 2008. He joined SINANO in 2009. His current research program focuses on the materials and interfaces in energy nanotechnology.