

Improving the Performance of Pitch-Derived Carbon Anode via Tuning Microstructures and Unraveling the Sodium Storage Mechanism in Disordered Carbon

Yaxiang Lu, Yunming Li, Chenglong Zhao, Xingguo Qi, Yong-Sheng Hu*, Hong Li, Xuejie Huang, Liquan Chen

Key Laboratory for Renewable Energy, Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China

E-mail: yxlu@iphy.ac.cn

Disordered carbons, normally divided and defined as the “soft carbon” and “hard carbon” according to their graphitization capability at the high temperature above 2500 °C, have been captured extensive interest as anode materials for Na-ion batteries (NIBs). Both of the two types have their own advantages and disadvantages, for instance, the fossil fuel derived soft carbon is cost-effective but generally delivers a capacity below 100 mAh/g while the biomass derived hard carbon typically has a sodium storage capacity of around 300 mAh/g but at the cost of either high precursor price or low carbon yield, which hinders their practical application.

To combine the advantages of both soft and hard carbons, here we developed facile strategies to turn the microstructures of carbons derived by pitch, a low-cost and high-carbon yield petrochemical byproduct, realizing an effective structural conversion from ordering to disordering at further carbonization process. The electrochemical results show that the pristine pitch-derived carbon anode only possesses sloping capacity while the treated pitch counterpart exhibits both sloping and plateau regions in the potential profile with the latter has a three-fold capacity enhancement.

The different microstructure-induced performances drive us to proceed the further investigations on sodium storage mechanism in disordered carbons. By taking treated-pitch derived disordered carbon as the model, with the assist of ex situ and in situ characterization techniques to probe the fine structure, for the first time we propose that the nanovoids filling in the low potential region correlates with the underpotential deposition (UPD). Based on the understanding, it is significant that the architecture of the disordered carbon could be optimized accordingly to further improve the capacity.

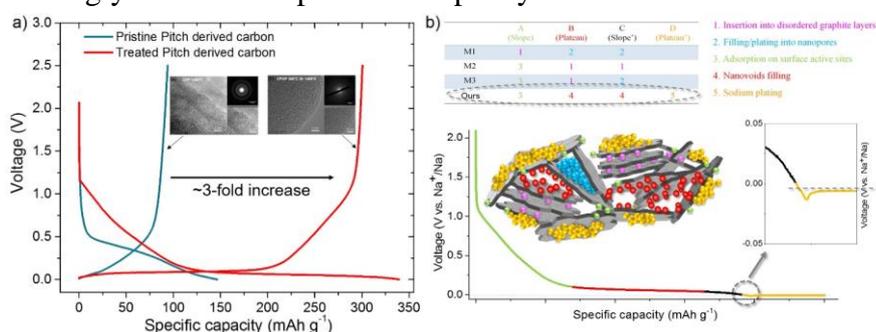


Figure 1 a) Voltage profiles of pristine and treated pitch derived carbons at 0.1C rate in the first cycle; b) Summary of currently proposed sodium storage mechanisms including ours.

References:

[1] Y. Li, Y. Lu, C. Zhao, Y.-S. Hu, M.-M. Titirici, H. Li, X. Huang, L. Chen, *Energy Storage Mater.*, 7 (2017) 130–151.