Yichao Cai
Xiaofei Hu, Jianchao Sun, Zifan Li, Yong Lu, Hao Yang, Jun Chen*
Key Laboratory of Advanced Energy Materials Chemistry (Ministry of Education), Nankai University, Tianjin, China

chenabc@nankai.edu.cn

Graphene and Carbon Nanotube in Na-CO_2 Battery

Abstract
Sharing the similar structure of 3-dimensional tri-continuous porous structure, multidimensional continuous electron-transport pathways and excellent mechanical strength, graphene and carbon nanotube have attracted enormous interest and been widely applied in metal-air battery. However, during the past decades, all reported Na-CO_2 batteries are non-rechargeable at room temperature in pure CO_2 atmosphere, which was caused by gas channel blockage, electro-conductivity decrease, and insufficient cathode wettability to electrolyte. In order to solve this leftover problem and to take the full advantages of those two carbon materials, we introdued the multi-wall carbon nanotube as the cathode of Na-CO_2 battery, and achieved the first rechargeable Na-CO_2 battery at room temperature. And with the help of a novel rGO-Na anode, a better electrichemical performance Na-CO_2 battery with higher safety has been able to be published. The introduction of multi-wall carbon nanotube could bring numerous advantages in CO_2 battery system. First, this 3-dimentioanal tri-continuous porous structure cathode could avoid the unwanted product clogging. Second, the high specific surface area and better electrolyte wettability contributed to an increased triple-phase boundary for discharging reaction. Third, the high electro-conductivity of multi-wall carbon nanotube could minimize the polarization during charge. Moreover,the amorphous carbon on the surface of multi-wall carbon nanotube is exactly the same product during the discharge, this reactive-carbon-rich cathode promised the easier charge progress for Na-CO_2 battery.[1,2] To replace the unstable Na metal anode, we proposed the rGO-Na composite anode for the first time, and appling to a high safty Na-CO_2 battey system.[3] Thanks to the unique structure and excellent physical property of graphene, the rGO-Na anode represented faster Na^+ diffusion rate and depressed Na dendrite growth. With the help of graphene and carbon nanotube, so many remarkable progresses have been made in Na-CO_2 battery, and they also hold a broad prospect of application in other metal-air batteries and commercial battery systems.

References

[1] X. Hu, J. Sun, Z. Li, Q. Zhao, C. Chen, J. Chen, Angew. Chem. Int. Ed., 55, (2016), 6482 - 6486
[2] J. Sun, Y. Lu, H. Yang, M. Han, L. Shao, J. Chen, Research, DOI: 10.1155/2018/6914626
[3] X. Hu, Z. Li, Y. Zhao, J. Sun, Q. Zhao, J. Wang, Z. Tao, J. Chen, Sci. Adv. 3, (2017), e1602396

Figures

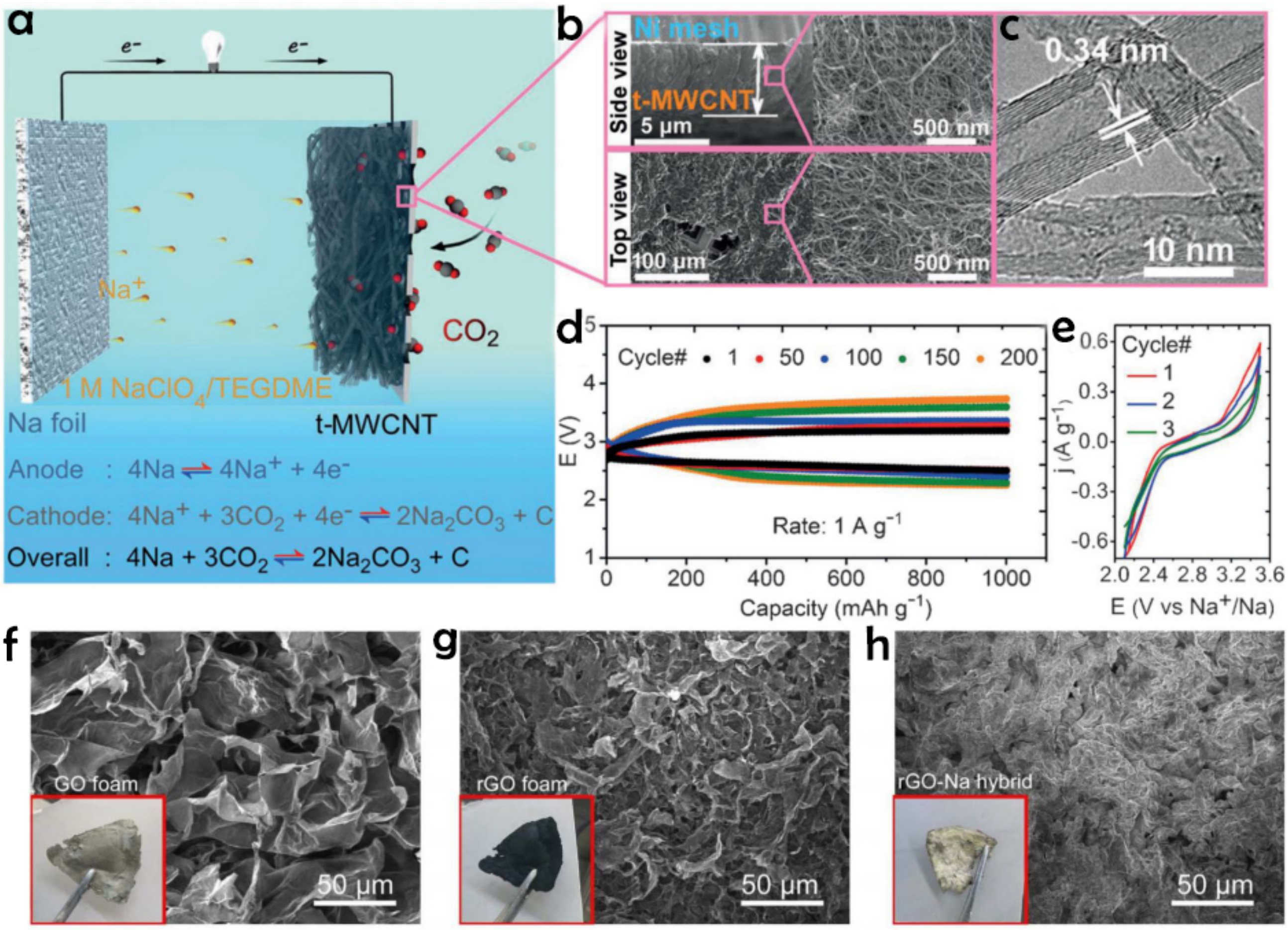

Figure 1: (a) Structure of Na-CO_2 batteries with metal Na foil anode, ether-based electrolyte, and t-MWCNT cathode. (b) SEM imagesof cathode from top and and side views. (c) HRTEM image of t-MWCNT. (d) Discharge and charge profiles of Na-CO_2 batteries at 1 A/g (e) CV curves of Na-CO_2 batteries with scan rate of 0.1 mV/s. SEM images with corresponding inset photographs of (f) GO foam, (g) rGO foam reduced by molten Na, and (h) rGO-Na anode surface