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Nitrogen-doped Carbon Nanostructures as Cathode for Lithium Air Batteries

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Lithium air battery, whose cathode active material could be absorbed from environment instead of stored in the batteries, is considered as a serious contender to satisfy the rapid growing requirements of electric vehicles and large-scale renewable energy storage, since it has a comparable energy density of gasoline. It is widely accepted that the performance of lithium air batteries strongly depends on the carbon cathode[1]. Nitrogen doping, as a feasible strategy for tuning physical and chemical properties of carbon materials, can lead to chemical activation and conductivity promotion of carbon materials.

In this present work, nitrogen doped carbon nanotubes (N-CNTs) and carbon aerogel are employed as cathode materials for lithium air battery. The discharge products were detected to illustrate the nitrogen doping effect.

Fig.1a and b shows the morphology of our as-synthesized carbon nanotubes (CNTs) and N-CNTs by a very simply chemical vapor deposition route[2]. Our research shows that the incorporation of nitrogen within nanotubes could effectively decrease the long-range crystallinity by introducing defects.

The performance of CNTs and N-CNTs at the current density of 100 mA g^{-1}, as shown in fig. 2, exhibits that N-CNTs displays a higher average discharge plateau than CNTs, indicating a higher activity for cathode reaction resulting from higher binding energy between carbon (or nitrogen) and oxygen after nitrogen doping[3]. In the same time, the discharge capacity of the nanotubes increases from 3483 mAh g^{-1} to 4637 mAh g^{-1} by nitrogen doping[3].

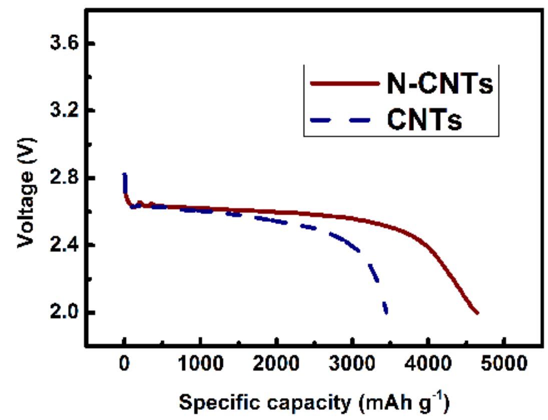

Fig 2, initial discharge profile of (a) CNTs and (b) N-CNTs as cathode in lithium air battery

To illuminate the reason why nitrogen doping could bring a higher capacity, the comparison of pristine CNTs and there nitrogen doped counterpart after discharge are carried out in figure Fig. 1c and d. The observation shows that the morphologies of the products on N-CNTs is more uniform compared with that on CNTs, which is attributed to the existence of nitrogen within N-CNTs making the tubes more defective and offering more electrochemistry reaction site[3].

Equivalent experiments are also executed on pristine and nitrogen-doped carbon aerogels. Resulting similar phenomena confirm that nitrogen-doping plays a positive role in carbon materials to elevate their lithium air battery performance. Our results provide a simple and promising way (nitrogen doping) in developing carbon electrode for lithium air batteries to enhance the battery performance.

References:

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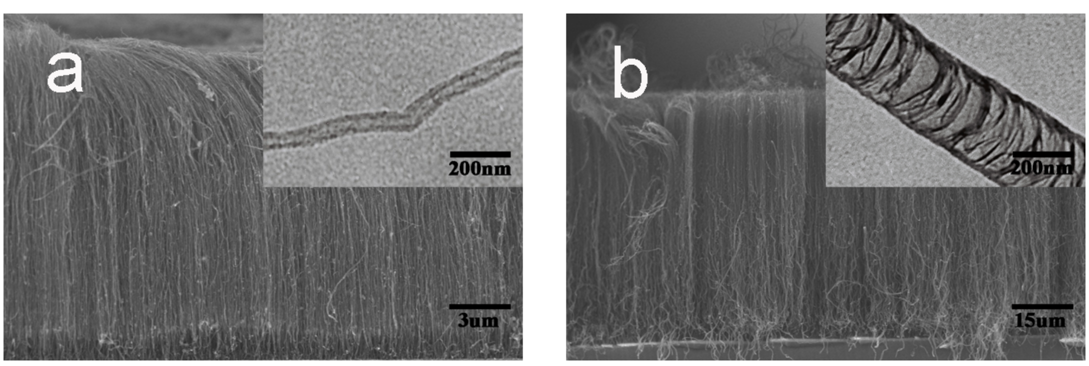

Fig 1, SEM and TEM morphology of CNTs(a) and N-CNTs (b)

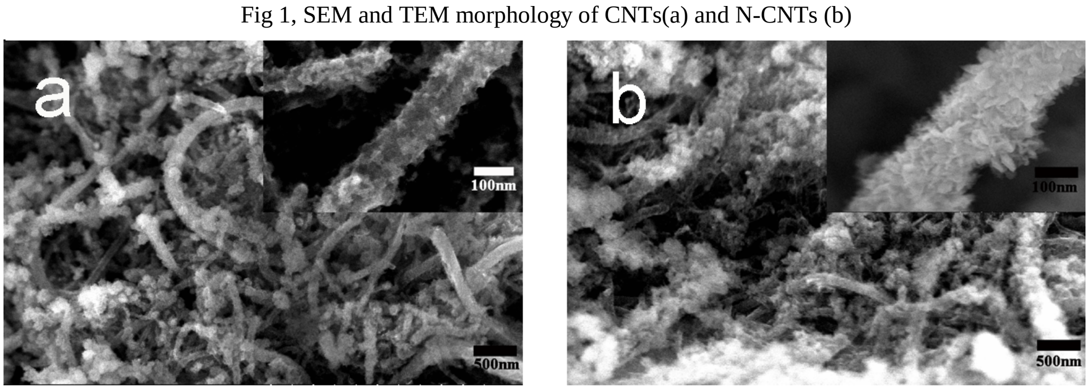

Fig 3, Comparison of discharge products on (a) CNTs and (b) N-CNTs