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Activation of Graphite for Low Cost and Fast Chargeable Lithium Ion Batteries

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Graphite, which is the most wildly used materials for lithium ion batteries, have a limited power density at high charging rates (lithiation), while their alternatives, such as silicon and tin alloys show even inferior rate capability [1-2]. Here we described activated graphite by chemical activation followed by carbon coating to form a nano-carbon coated multichannel structure which could enable quick access of lithium ions to the inner graphite particles for fast chargeable lithium ion batteries [3]. The as synthesized materials which were systematically investigated by XRD, FT-IR, Raman spectroscopy and Brunauer-Emmett-Teller (BET) measurements were assembled into laminate-type cells vs lithium metal for electrochemical investigation such as charge/discharge, Cyclic Voltammetry (CV), Electrochemnical Impedance Spectroscopy (EIS). The morphology and micro-structure of the carbon materials were characterized by SEM and high resolution TEM.

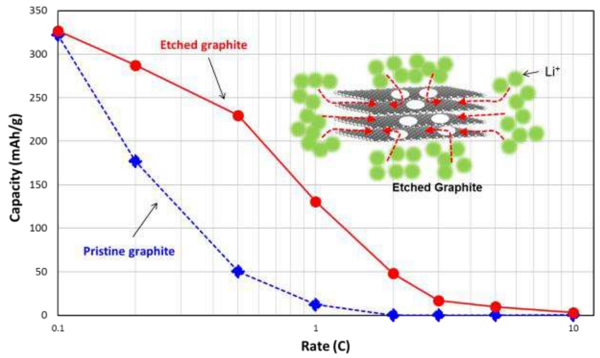

Figure 1. Rate capability and mechanism schematic scheme comparison of pristine graphite and chemical activated graphite. The inserted image is the schematic scheme of etched graphite.

The reversible capacity of the activated graphite reaches 337.4 mAh/g with the columbic efficiency higher than 90% under a practical mass loading of 50 g/m^2. Moreover, the electrode also exhibits outstanding lithiation rate capability with reversible capacity around 10 times at 1C compared with commercially available graphite materials at 25 ℃(Figure 1). The activated materials also showed good stability of almost no capacity fading up to 100 cycles. The excellent electrochemical stability and high rate capability are attributed to the tailored nano-carbon coated multichannel open holes structure of activated graphite which showed in the inserted graph of Figure 1 and enlarged interlayer spaces at the lithium entrance, which showed in Figure 2. Such electrodes materials are envisioned to be mass scalable with simple and low-cost fabrication procedures, thereby providing a clear pathway toward commercialization.

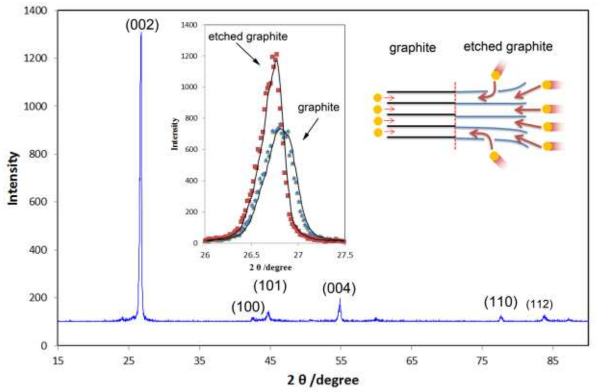

Figure 2. XRD result of KOH etched graphite. The inserted image is the (002) peak comparison of pristine graphite and KOH etched graphite and schematic scheme.

Reference

[1] H. Azuma, H. Imoto et al. Journal of Power Sources 81-82 (1999) 1-7.
[2] S. Flandrois, B. Simon. Carbon 37 (1999) 165-180.
[3] Y. W. Zhu, R. S. Ruoff, et al. Science 332 (2011) 1537-1541