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リチウムイオン電池用グラフォイル上の垂直配向カーボンナノシート

Vertically-Aligned Carbon Nanosheets on Graphite Foils for Lithium Ion Batteries

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Lithium ion batteries (LIBs) with high power density have been extensively investigated due to wide applications as power sources from portable electronic devices to electric and hybridelectric vehicles [1]. In order to meet growing demands for their longer-lasting and more powerful performances, LIBs require new and advanced materials and novel synthesis techniques. One candidate for anode material of LIBs should have high lithium storage capability and stable structure after repeated charge-discharge cycles. Since the first commercialization of LIBs, graphite as anode materials is widely accepted because of its high reversible energy capacity, stable and broad electrochemical window, and plentiful supply. Besides graphite, other carbon-base materials have also been employed to develop novel anodes to enhance electron transfer and kinetics. Recently vertically-aligned carbon nanosheets (CNSs) which were dominantly synthesized by plasma-enhanced chemical vapor deposition techniques with carbonaceous materials as carbon sources on the various substrates have attracted great interest due to their high surface area, high electrical conductivity, and high chemical stability [2]. Some works have shown that the vertically-aligned CNSs can be used as the anode materials of LIBs with higher capacity than graphite because of their shorter conductive path of lithium ions [3]. In addition, it has been reported that heat treatment of CNSs in inert atmosphere can further improve their performances in LIB applications [4]. In order to systemically consider their effect of heat treatment temperatures on LIB performances, the CNSs were directly fabricated on the graphite foil substrates as LIB anodes because of high temperature durability of graphite.

In this work, the microwave plasma-enhanced chemical vapor deposition (MPECVD) technique was employed to synthesize the vertically-aligned CNSs on graphite foil substrates with the supplies of H_2 and CH_4 gases. The morphologies and microstructures of the vertically-aligned CNSs are shown in Figure 1. Subsequently, the as-synthesized CNSs were treated using the graphite resistance furnace with an inert atmosphere in the temperatures of 800-3000 ^{o}C. After high temperature treatments, the treated CNSs as anode materials were assembled in coin cells with Li as cathode for LIB measurements. The detailed results will be presented in the coming meeting.

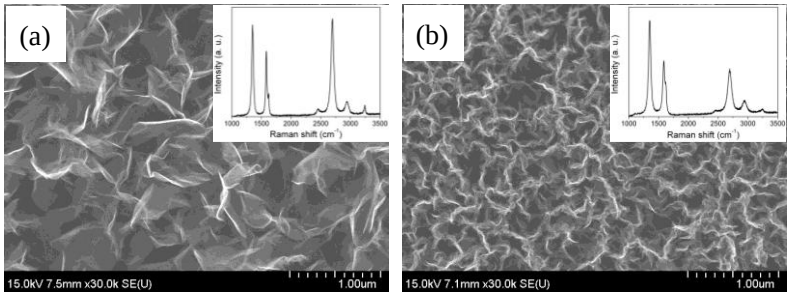

Figure 1 SEM images of vertically-aligned CNSs on the substrates of Cu (a) and grafoil (b) by MPECVD technique in H_2-CH_4 system. Insets show respective Raman spectra in (a) and (b).

References

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