

Advanced Anode for High Energy and High Power Lithium Batteries

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Lithium ion battery is the technology of choice for electric based transportation. The current lithium ion battery is utilizing carbonaceous anodes and layered oxide cathodes. The energy and power density of this technology needs to be improved for transportation applications. In particular, the anode has limited capacity, 370 mAh/g, and needs significant improvement to satisfy the requirement for hybrid vehicles.

Applied Sciences, Inc. (ASI), in collaboration with General Motors Research, has developed a unique and stable silicon-carbon powder for use as an anode material that provides a four-fold improvement in the charge capacity of Li ion batteries to approximately 1000 - 1500 mAh/g. This represents the first observed low irreversible capacity loss during the first cycle as well as stable capacity to high cycle numbers. This new electrode material can dramatically improve the performance of lithium-ion batteries in many applications, including high-energy, high-power batteries needed for transportation vehicles.

The basis of this advanced anode is the incorporation of carbon nanofiber as a substrate material to provide enhanced electrical conductivity and serves as a host for selected alloys. Carbon nanofiber is a highly graphitic material with an average diameter of 100 nanometers and an aspect ratio in excess of 1000. Figure 1 is an SEM view of the graphitic nanofiber

used in this study. Figure 2 is a HR TEM view of the carbon nanofiber sidewall revealing the composition of the fiber morphology in the form of nested conic graphene.* This nested cone morphology is a unique structure which facilitates surface alloying. This characteristic also provides high rate capability for high charge/discharge processes. This paper will discuss the electrochemistry of the silicon modified carbon nanofiber leading to the observed performance values.

*HR TEM provided courtesy of Dr. Jane Howe at ORNL.

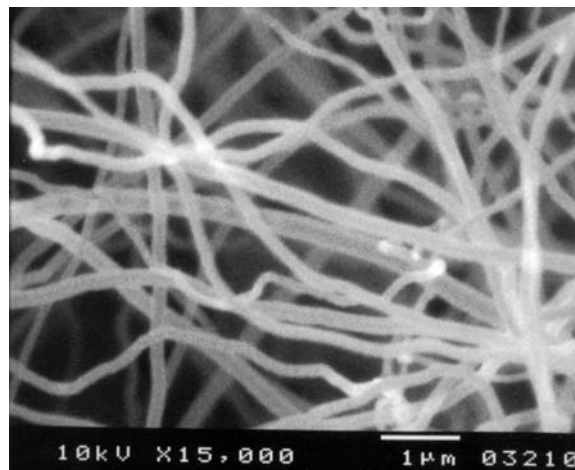


Figure 1. SEM of carbon nanofibers

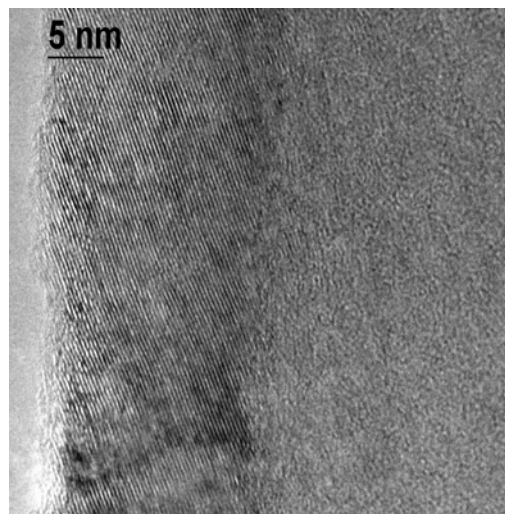


Figure 2. HR TEM of carbon nanofiber