Strong Flexible Free-standing Fe_3O_4/Graphene-MWCNT Hybrid Film for Flexible Energy Storage Devices

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Now a days, arise of the global energy problems, which are resource exhaustion, wrenching climate change, and environmental pollution, have influenced the exchange of the energy industry paradigm from an oil-based economy to an electricity-based economy. Lithium ion rechargeable batteries (LIBs) and supercapacitors are one of the most promising candidates for energy storage system for portable devices or electronic vehicles. However, it is still challenging and imperative to develop the industry-requiring properties of electrochemical energy storage devices, which are flexibility with better mechanical properties and increasing amount of specific energy based on the entire device mass or volume. There have been various approaches to evaluate flexibility on the electrochemical devices composed of 1D carbon nanotubes or 2D graphene due great electronic properties. However, in spite of enhanced flexibility and electrochemical performance, the lack of mechanical properties is still one of the confront problems. Additionally, traditional electrodes in the typical electrochemical devices have a low actual specific capacity due to use of current collector, binder, and conductive material. Therefore, it is another challenge to increase the specific capacity based on the mass or volume of the entire device.

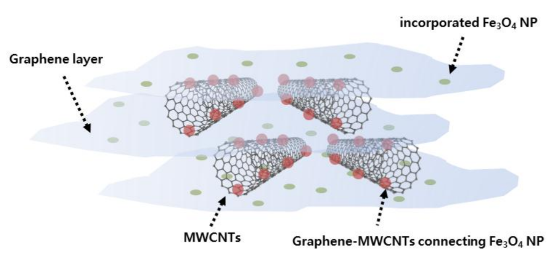

Figure 1. Schemetic image of FGCHF.

In the present research, we develop the free-standing Fe_3O_4/graphene-MWCNT hybrid film (FGCHF) for anodes of LIBs which is not only strong but also flexible. In detail, we successively introduced FGCHF without binder or conductive material through preparation of graphite oxide (GO)-MWCNT film followed by Fe_3O_4 nanoparticle incorporation using hydrothermal reaction and heat treatment. GO-MWCNT film (Figure 1) indicated better mechanical properties compared to single GO or MWCNT films, which make possible to be free-standing film. Also, incorporated anodic materials, Fe_3O_4 nanoparticles, reduce and connect GOs and MWCNTs achieving better electronic and mechanical properties (Figure 2). Therefore, FGCHF has opportunity to enhance electrochemical performances with flexibility, due to no use of binder and conducting material and improved electronic properties from graphene-MWCNT hybrid film substrate.

Material characteristics, mechanical properties and electrochemical performances of the FGCHF as anode for the LIBs were investigated with various analytic methods and electrochemical tests.

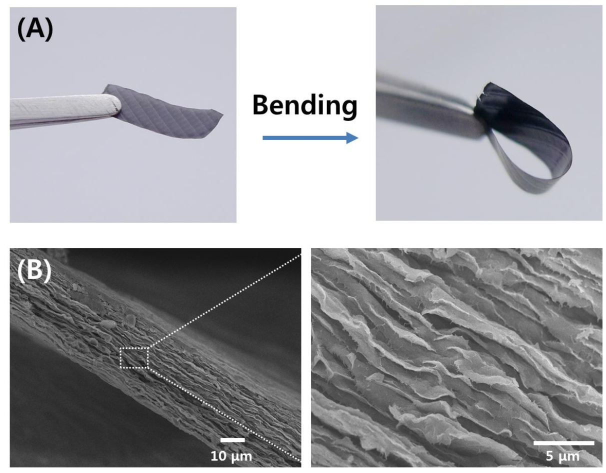

Figure 2. (A) Optical images and (B) FE-SEM images of GO-MWCNT hybrid substrate.