Flexible 3D Composite of Graphene and Carbon Nanotube for a High-performance Energy Storage Device

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Abstract

Graphene is the most noteworthy candidate 2-dimentional material for high-performance energy storage device. Because it has distinguished chemical stability, extraordinarily high electrical conductivity, large surface area, and great mechanical strength. Because of these useful properties of graphene, it have been used electrode material in energy storage device such as supercapacitor. For electrode of energy storage device, it is important that the electrode has large surface area to volume ratio. Therefore, graphene oxide has been commonly used for forming sponge, because graphene oxide easily can be separated in a water solution.

However, the strong π–π interaction between graphene sheets and defects that oxygen-containing chemical groups lead to decrease of its electrical properties. These disadvantages limit the electrical performance of graphene device. Hence, various methods are used to fabricate graphene sponge for overcoming limitation of the graphene sponges. However, graphene sponge have not been shown appropriate electrical performance for supercapacitor. Because when graphene form porous structure, it is difficult that the graphene adhere to each other compactly. As a result, at border between graphene sheets current cannot flow smoothly.

To solve this conductivity problem, we form carbon nanotube (CNT) network on surface of graphene sponge. The CNT network are laid on surface of graphene sponge and adhere, wind and couple graphene sheets. Because CNT has also highly electrical conductivity, graphene sponge/CNT composite can show highly electrical conductivity and can provide superb performance.

In this research, to form graphene sponge and CNT composite, we fabricated graphene sponges first by using various methods for identifying which sample can achieve better performance than others. That sponges were fabricated by dipping method, hydrothermal method, and CVD-grown method. After forming graphene sponges, CNT network was formed by adhesion method or was grown by using CVD method including metal catalyst such as Ni, Fe. CNT network arrayed on surface of graphene sponge was identified by FE-SEM device.

To measuring electrical properties of graphene sponge/CNT composite, we checked the I-V characteristics and CV. After measuring, we compared with each samples fabricated by different methods and other materials – graphene sponge before forming CNT network, 3D graphene.

As a result, this study suggests that suitable composites of carbon material like graphene sponge/CNT composite can overcome limitation of each individual carbon material and can show highly good performance of electrical properties, and next issue for composite of carbon materials is developing applications such as gas sensor or supercapacitor electrodes.

References

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Figures

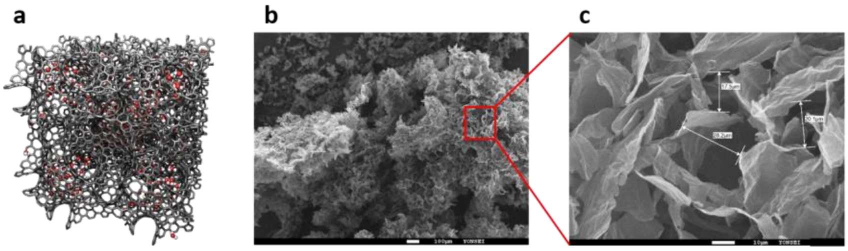

Figure 1. Graphene sponge: (a) Schematic of graphene nanoporous structure (b) SEM image with x55 magnification of graphene sponge (c) SEM image with x1,000 magnification of graphene sponge