Experimental Investigation on 3D Graphene-CNT Hybrid Foams with Different Interactions

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Received: 18 August 2018; Accepted: 3 September 2018; Published: 6 September 2018

Abstract: Due to the exceptional properties of graphene, numerous possibilities for real applications in various fields have been provided. However, it is a challenge to fabricate bulk graphene materials with properties arising from the nature of individual graphene sheets, and which assemble into monolithic three-dimensional structures. If 3D structured graphene foam were made instead of 2D structured graphene, it is expected that it would be a facile fabrication, with relatively low cost with the possibility of scale-up, and would maintain the intrinsic properties of graphene. To solve the weaknesses of 2D structured graphene, this study aimed to fabricate a 3D graphene-carbon nanotubes (CNT) hybrid foam. In this study, CNT was used to reinforce the graphene foams. In addition, two different surfactants, known as sodium dodecylbenzene sulphonate (SDBS) and cetyltrimethylammonium bromide (CTAB), were applied to help CNT dispersion. The π–π interaction was induced by SDBS/CNT, while ionic interaction was derived from CTAB/CNT. To confirm the charge effect with different surfactants, SEM, Zeta-potential, FT-IR, Raman spectroscopy, and compression tests were performed. When using a cationic surfactant, CTAB, compressive modulus, and strength increased due to the formation of relatively strong ionic bonding.

Keywords: graphene oxide; carbon nanotube; hybrid foam; surfactants; charge effect

1. Introduction

Graphene has come into the spotlight owing to its extraordinary properties [1–5]. Graphene plays a significant role in a variety of fields, such as electronics, biomedical, energy storage devices, sensors, and other fundamental research fields [6,7]. Although graphene is the driving force behind various fields, it has several drawbacks, which are non-effective mass production, high cost, difficulty in controlling high-quality materials, defects, dispersion problems, and interphase of matrix-filler when becoming composite materials, and so on [8].

Recent studies have revealed that 3D graphene architectures have arisen as a keyword to resolve the aforementioned negative points of fabrication of graphene [9]. Otherwise, it would not be possible to translate the outstanding properties of 2D graphene at an industrial level. To improve some