Characterization Analysis According to Growth Temperature of Carbon Nanowall on Metal Coated Substrate for Electrode Application of Energy Storage

Jong Kug Park1,a, Wonseok Choi1,b†, Hyun-Suk Hwang2,c, Kyoung Hak Lee3,d, Jung Hyun Kim4,e, and Yeun-Ho Joung5,f

1 Department of Electrical Engineering, Hanbat National University, Daejeon 34158, Republic of Korea
2 Department of Electrical Engineering, Seoil University, Seoul 02192, Republic of Korea
3 IACF Kwangwoon University, Seoul 01897, Republic of Korea
4 Department of Applied Materials and Engineering, Hanbat National University, Daejeon 34158, Republic of Korea
5 Department of Electronic and Control Engineering, Hanbat National University, Daejeon 34158, Republic of Korea

xa3xc@naver.com, bwschoi@hanbat.ac.kr,ckonae@seoil.ac.kr,dgoldbug@kw.ac.kr,ejhkim2011@hanbat.ac.kr,fyhjoung@hanbat.ac.kr

Keywords: Carbon based nano-meterials, Carbon nanowall, High efficiency electrode, Thin film, Annealing, Plasma, PECVD

Abstract. Secondary cells, which are the core storage media of energy storage systems (ESS), and carbon nanowalls (CNWs), which are expected to improve the performance of supercapacitors while being used as their electrodes, were investigated in this study. CNWs were directly grown on the substrate, and the substrate was a Si wafer with a nickel layer deposited on top of it. The nickel layer was deposited with the RF-magnetron sputtering method using a 4-inch Ni target. The CNWs were grown on the prepared substrate using microwave plasma-enhanced chemical vapor deposition (PECVD). The substrate temperature was changed from 550 to 800oC by 50oC increments to identify the growth characteristics according to the growth temperature. The surficial and cross-sectional images according to the temperature were analyzed using a field emission scanning electron microscope (FE-SEM). It was confirmed that the density of the CNWs increased along with the temperature. Especially, it was confirmed that the density increased dramatically at 750oC or higher.

Introduction

Super capacitors and second cells are mostly used in large-capacity power storage devices such as energy storage system (ESS), and many studies are being conducted to improve the efficiency and economic feasibility of such energy storage devices[1,2]. While porous carbon has been used as a carbon-based electrode material for energy storage devices, studies were recently conducted to enhance the electrode efficiency using carbon-based nanomaterials such as carbon nanotubes (CNTs)[3] and graphene[4]. CNT requires a metal catalyst for synthesis, and a post-treatment process must be followed to improve its purity. Also, it is difficult to accurately formulate and disperse CNT when it is used as an electrode material[5,6]. As graphene has a one-dimensional planar structure, its reactivity is higher than that of CNT, which has a two-dimensional structure. It is difficult, however, to develop a large-scale and high-quality synthesis technology for the commercialization of graphene[7]. Carbon nanowalls(CNWs), which were found during the synthesis of CNT, are carbon-based materials and have a two-dimensional structure in which several layers of graphene are vertically grown on a substrate[8,9]. CNWs with this unique appearance have the largest reaction surface area among the carbon-based materials. As CNWs are carbon-based materials, they have high electrical conductivity and electron affinity. Therefore, they can be used as electrode materials to