Effects of Catalyst Support and Chemical Vapor Deposition Condition on Synthesis of Multi-Walled Carbon Nanocoils

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Abstract. Multi-walled carbon nanocoil (MWCNC) is a carbon nanotube (CNT) with helical shape. We have synthesized MWCNCs and MWCNTs hybrid by chemical vapor deposition (CVD). MWCNCs are considered to be a potential material in nanodevices, such as electromagnetic wave absorbers and field emitters. It is very important to take into account the purity of MWCNCs. In this study, we aimed to improve the composition ratio of MWCNCs to MWCNTs by changing catalyst preparation and CVD conditions. As a catalyst, Fe_2O_3/zeolite was prepared by dissolving Fe_2O_3 fine powder and Y-type zeolite (catalyst support material) in ethanol with an Fe density of 0.5wt.% and with a zeolite density of 3.5wt.%. The catalyst-coated Si substrate was transferred immediately onto a hotplate and was heated at 80°C for 5 min. Similarly, Fe_2O_3/Al_2O_3, Co/zeolite/Al_2O_3, Co/zeolite, and Co/Al_2O_3 were prepared. The effect of the difference of the composite catalysts on synthesis of MWCNCs was considered. The CVD reactor was heated in a tubular furnace to 660-790°C in a nitrogen atmosphere at a flow rate of 1000 ml/min. Subsequently, acetylene was mixed with nitrogen at a flow rate ratio of C_2H_2/N_2 = 0.02-0.1. The reaction was kept under these conditions for 10 min. MWCNTs and MWCNCs were well grown by the catalysts of Co/zeolite and Co/Al_2O_3. The composition ratio of MWCNCs to MWCNTs was increased by using a combination of zeolite and Al_2O_3. The highest composition ratio of MWCNCs to MWCNTs was 12%.

1. INTRODUCTION

Nanotechnology holds potential not only for miniaturization, densification, and increasing device performance but also for changing nanometer-scale physical properties and creating products with novel functions. Therefore, materials for nanotechnology are now intensively researched. Among them, carbon nanomaterials have attracted considerable attention since the discovery of fullerene in 1985 [1]. Carbon nanotubes (CNTs) [2, 3] and various types of carbon nanofibers (CNFs) [4] have also drawn increasing attraction.

Fullerene has a spherical shell structure of several tens carbon atoms, and its shell is composed of five-membered rings as well as six-membered rings of carbon atoms. CNTs are composed of a rolled-up graphite sheet, in which six-membered rings of sp^2-bonded carbon atoms form two-dimensional network. Carbon nanocoil (CNC) is a helical carbon nanofiber (CNF) and has a coil diameter of several hundreds of nanometers [5, 6]. CNFs and CNCs are mainly composed of amorphous carbon.

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