Aluminum Oxide Support Layer for Vertical Growth of Single Walled Carbon Nanotube using Alcohol Catalytic CVD Technique

Mohd Asyadi Azam [1], Akihiko Fujiwara [2], Tatsuya Shimoda [1]

[1] School of Materials Science, Japan Advanced Institute of Science and Technology

[2] Research & Utilization Division, Japan Synchrotron Radiation Research Institute

During the last two decades, carbon nanotubes (CNTs) have received much attention from both the scientific and industrial communities due to their structural properties and the unique morphology. There also has been growing interest in densely packed or vertically aligned single walled CNT (VA-SWCNT) because of their suitability in high potential applications such as supercapacitors, electrodes for lithium-ion batteries, and nanotube-polymer composites [1, 2]. Well aligned CNT arrays on the substrates offer morphology advantages for those applications compared to those with random and entangled form of CNT that required modification or adjustment. Various methods including the chemical vapor deposition (CVD) have been developed to grow vertically aligned SWCNTs. Among them the alcohol catalytic CVD (ACCVD) method [3] is a promising one which is well-known for its economical merit, wide selectivity of substrates and highly yielding catalytic reaction to grow the CNTs. One of the catalyst commonly used for CNTs growth using ethanol is the thin Co film (~ 1nm thick) supported on an aluminium oxide film with thickness in the range of 10 ~ 50 nm. Using this catalyst and hydrocarbon feedstock, highly dense SWCNTs of even up to millimetre-scale heights can be achieved via the CVD growth technique [4]. In order to fully understand the mechanism of uniform vertically aligned SWCNTs, a detailed knowledge on the role of the support or buffer layer used is really essential as a start point.

Here we report our research work on different type of Al oxide support layer in order to produce VA-SWCNTs. The electron beam (EB) deposition was mainly used to deposit high purity Al and Al_2O_3 thin film (20 nm). For the as-deposited Al metal layer, several oxidation treatments were elucidated to confirm the different in physical and chemical structures to act as catalyst support material. The post deposition oxidation treatments are natural oxidation, thermal oxidation, UV ozone, and plasma ashing oxidation. Characterization and analytical studies will be carried out by XPS, XRD, AFM, and SEM in order to understand what type of Al oxide support layer is suitable to support Co catalyst for VA-SWCNTs growth. This important research work is a reliable and good approach to deeply understand the step-by-step mechanism before implementing the device or application oriented studies.

References:

[1] R. Philippe *et. al.*, *Journal of Catalysis* **263** (2009) 345.
[2] P.B.Amama *et.al.*, *ACS Nano* **4** (2010) 895.
[3] M. A. Azam *et. al.*, *Japanese Journal of Applied Physics* **49** (2010) 02BA04.
[4] H.Sugime *et.al.*, *Carbon* **48** (2010) 2203.