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支援課題名（日本語） : カーボンナノウォールの特性と応用
Program Title（in English） : Properties and Applications of Carbon Nanowalls
利用者名（日本語） : ジェマリウス
Username（in English） : Gemma Rius
所属名（日本語） : 名古屋工業大学
Affiliation（in English） : Nagoya Institute of Technology

概要（Summary）：

The integration of carbon nanomaterials having peculiar, determined specifications and properties, presents fabrication and synthesis control challenges. The current attention towards the potential of graphene-like materials evidences the necessity to deepen their preparation and performance for targeted uses.

Following some of the work I started during my fellowship at the SSL of TTI, the idea is to continue (i) the analysis of the deposition and characteristics of CNWs, and (ii) the exploration of their use for catalysis, charge storage, template for nanoparticles growth, etc.

Two particular focuses continue to be developed: 1) supercapacitor application of CNWs, and 2) study of Bi nanoparticles growth on CNWs templates and other supports.

実験（Experimental）：

Oriented to applications evaluation, new conditions are being tested and the processing parameters are adapted in order to engineer the CNW growth toward desired architectures (see next section for some details on CNWs deposition for the supercapacitor application).

In other cases the job simply implies producing sets of samples to be provided to the collaborators and corresponding to the designed experiment, for example, for their trials concerning to study the growth variables of Bi nanoparticles.

Equipment: Synthesis of CNWs on various substrates using the Microwave Plasma Enhanced CVD from ULVAC, located at the Clean Room of Toyota Technological Institute.

結果と考察（Results and Discussion）：

Concerning to the supercapacitor application of CNW, development in collaboration with U. of Cambridge, we are working in a new evaluation of their charge storage performance using an advance architecture, as it has been done for CNTs in [1] and [2]. First, we designed the experiment and fabricated the supports to enable a selective CNW growth - sample supports like shown in Figure 1, i.e. SiO_2 interdigital microelectrodes on a Si support.

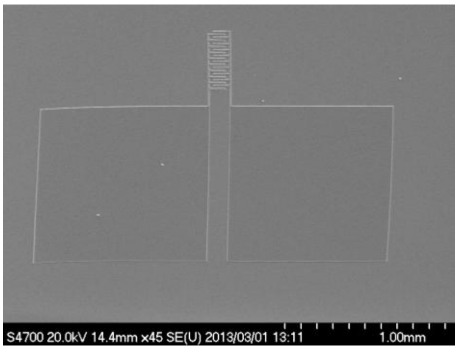

Figure 1. Micropatterned electrodes supplied by U. Cambridge to test the site-selective CNW deposition.

Results of tests in Figure 2 show that selective growth is not easily obtained and most importantly, conductive surfaces formed by the CNW mat are in electrically contacting Si area and patterned regions, in spite of the topography of the SiO_2 patterns (SiO_2 thickness is 500 nm. In the case of using additional Cu film deposited on top SiO_2 patterns, Cu thickness is, additional, 200 nm).

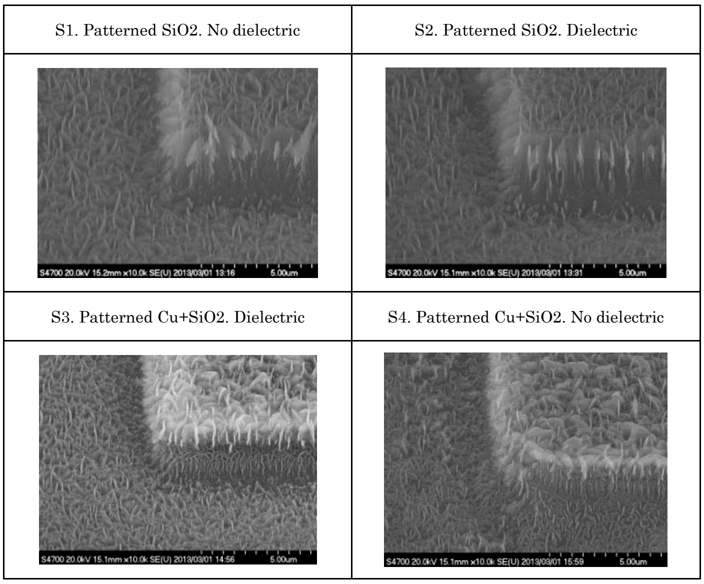

Figure 2. Tilted SEM image. Some examples of the CNW deposition tests on patterned SiO_2 samples (S1, S2) and patterned Cu/SiO_2 samples (S3, S4), Si is the bulk material. Using standard processing conditions and time, no selective growth is achieved. Dielectric, no dielectric refers to some configuration during growth process.

Raman Spectroscopy confirms that essentially there is no variation on the structural characteristics of the deposited CNW materials, although being done on the different support materials - SiO2, Si and Cu. This fact confirms the idea that, rather than a chemistry-based deposition technique, the current synthesis may be considered mainly a physics-driven deposition.

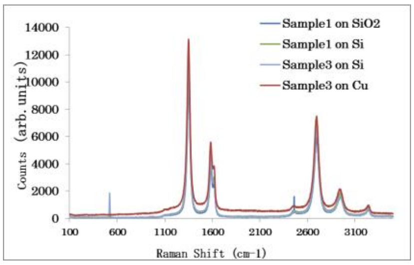

Figure 3. Raman spectroscopy of CNWs deposited, as Figure 2.

However, testing preliminary stages of CNW growth (1 minute) (see Fig. 4) demostrate that effectively there is a distintive deposition rate on SiO2 (upper area, Fig.4) respect to Si (lower area, Fig. 4)

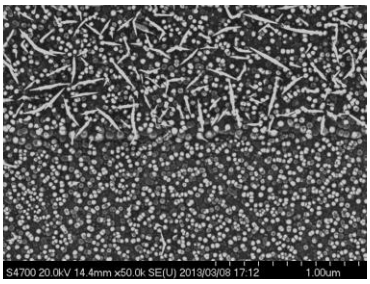

Figure 4. Top view SEM image. Deposition of CNW (elongated items) on patterned SiO_2/Si supports. Deposition rate is clearly higher on SiO_2 areas (upper region), as compared to bulk Si (no CNW region).

Because it seems too challenging to be capable of adjusting patterned growth based on the CNW conditions and together with sample specifications, next work will be based on a technological development consisting on uniform growth of CNWs and subsequent patterning of desired features (e.g. interdigital microelectrodes, as in Fig 1, patterned in a CNW post-deposition step.).

This year we will write a book chapter for the Handbook of Graphene Science, Taylor and Francis Ed. based on this work and some previous characterization of the electrical double layer performance of CNWs.

その他・特記事項（Others）：

参考文献（References）

[1] Majid Beidaghi and Chunlei Wang Adv. Funct. Mater. 2012, 22, 4501–4510.

[2] Planar mems supercapacitor using carbon nanotube forests, Y.Q. Jiang, Q. Zhou, and L. Lin.

共同研究者等（Coauthor）: Tests of the CNW applications are done in collaboration with:

1. Politecnico di Torino, Italy. Professor Alberto Tagliaferro and Dr Pravin Jagadale
2. University of Cambridge, UK. Professor Gehan Amaratunga and Dr Pritesh Hiralal

論文・学会発表（Publication/Presentation）:

a. Rius, G., Yoshimura, M. e-Journal of Surface Science and Nanotechnology, 10, pp. 305-309.
b. Rius, G., Yoshimura, M. Journal of Physics: Conference Series (2013) 417 012010

1. P Jagdale et al.Carbon Materials 2012 (CCM12)
2. G. Rius et al. ISPlasma 2013.