

Growth Control of Carbon Nanotube Forest for Electronic and Photonic Devices

Project Leader

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Objective

The characteristic electrical, chemical, physical and optical properties of carbon nanotubes (CNTs) are directly derived from their unique structures [1, 2, 3, 4, 5], such as (a) anisotropic electrical conductivity of horizontally aligned CNTs placed on substrates, and (b) anisotropic optical absorption for vertically aligned CNTs grown on substrates. A carbon nanotube forest is a vertically aligned CNT structure grown on substrates means of the chemical vapor deposition. Highly controlled PVD/CVD processes, including self-organization of catalyst particles, are desired to achieve unique highly oriented and periodically positioned CNT forests for new electronic and optronic applications with surprising properties.

Project Outline

Electromagnetic metamaterials[5, 6], composed of CNT forest meta-atoms, will be synthesized from height controlled, highly oriented vertically aligned CNT forests using a photolithography process. To realize the electromagnetic metamaterials, the following items will be developed in this project: (1) structure control of CNTs in diameter (in 1-100 nm) and (2) in growth height (in 10 nm - 10 μ m); (3) the design of an electromagnetic circuit for CNT forest metamaterials, and (4) photolithography process at the electromagnetic scale of 10 - 100 μ m. [5, 6]

References

- [1] "Crystal Structure Analysis of Multiwalled Carbon Nanotube Forests by Newly Developed Cross-Sectional XRD Measurement", H. Furuta, T. Kawaharamura, M. Furuta, K. Kawabata, T. Hirao, T. Komukai, K. Yoshihara, Y. Shimomoto, and T. Oguchi, Appl. Phys. Express 3 (2010)105101.
- [2] "Simulation study of the in-plane type triode carbon nanotube emitter", H. Furuta, K. Ishii, K. Okada, M. Furuta, and T. Hirao, J. Vac. Sci. Technol. B 28(4), (2010) 878-881. (selected paper for the issue of Virtual Journal of Nanoscale Science & Technology, vol22, Issue 7. August 16, 2010)
- [3] "High-density short-height directly grown CNT patterned emitter on glass", H. Furuta, T. Kawaharamura, K. Kawabata, M. Furuta, T. Matsuda, C. Li, T. Hirao, e-J. Surf. Sci. Nanotech. 8(2010)336-339.
- [4] "Stacked Self-standing Carbon Nanotube Forest Films utilizing Periodical Multi-layered (Fe/AlN)_n Films", H. Furuta, H. Koji, T. Harigai and A. Hatta, TechConnect World 2012 (Santa Clara, CA, Jun. 18-22, 2012).
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- [6] Kakenhi database: <http://kaken.nii.ac.jp/en/p/24560050>

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