

# Exploitation of Untrodden Field of Carbon-Based Nano-Bio Research Using Innovative Plasma Technology

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## 【Outline of survey】

The purpose of this research is to create novel structured single-walled (SWNTs) and double-walled (DWNTs) carbon nanotubes encapsulating various kinds of charge-spin controlled atoms, atom-encapsulated C<sub>60</sub>, DNA, and colloid in their inner nanospace and to clarify the new-functionality of these ultrastructured SWNTs and DWNTs, where we apply original doping approaches using nanoscopic plasma technology to the liquid phase in consideration of exploitation of an untrodden field of carbon-based nano-bio research.

As a first step, we form individually- and vertically-aligned SWNTs using diffusion-plasma enhanced chemical vapor deposition. Next, for the purpose of creating pn-junction structured SWNTs, ferromagnetic-metal-, DNA-, and colloid-encapsulated SWNTs using a plasma-ion irradiation method, we generate different-polarity ion gas plasmas composed of alkali/halogen or alkali/atom-encapsulated-C<sub>60</sub> ions, and electrolyte plasmas in the DNA and/or colloid solution.

Finally, we clarify the new-functionality such as ballistic transport, semiconductor and diode characteristics, superconductivity, spin-magnetism, luminescence, molecular recognition, and so on, by measuring the electric, magnetic, and optical properties of the ultrastructured SWNTs and DWNTs.

## 【Expected results】

The new-functional one-dimensional nano-bio devices such as pn-junction structured SWNTs, ferromagnetic-metal-, DNA-, and colloid-encapsulated SWNTs are expected to be created for the first time using the original method of plasma-ion irradiation to the individually- and vertically-aligned SWNTs in the gas and liquid phases.

These results will be able to achieve an academic and interdisciplinary significance of pioneering the untrodden field of nano-bio science based on innovative plasma science and contribute to systematization of the academic basis on nanospace control using plasma technology.

## 【References by the principal researcher】

- “Cesium Encapsulation in Single-Walled Carbon Nanotubes via Plasma Ion Irradiation: Application to Junction Formation and *Ab Initio* Investigation”, G. -H. Jeong, A. A. Farajian, R. Hatakeyama, T. Hirata, T. Yaguchi, K. Tohji, H. Mizuseki, and Y. Kawazoe: Physical Review B, **68**, 075410-1-6 (2003).
- “Electrically Triggered Insertion of Single-Stranded DNA into Single-Walled Carbon Nanotubes”, T. Okada, T. Kaneko, R. Hatakeyama, and K. Tohji: Chemical Physics Letters, **417**, 288-292 (2006).

【Term of project】 FY2006 - 2010

【Budget allocation】 31,600,000 yen

【Homepage address】

<http://www.plasma.ecei.tohoku.ac.jp/>