

【Grant-in-Aid for Scientific Research (S)】
Science and Engineering (Chemistry)



Title of Project: Fabrication and Characterization of Novel Nano-Materials Using One- and Two-dimensional Reaction Fields

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Research Project Number : 16H06350 Researcher Number : 50132725

Research Area : Fundamental Chemistry

Keyword : Carbon nanotubes, Graphene, Reaction Fields

【Purpose and Background of the Research】

Based on our past achievements and background in nano-peapods studies, it is not until relatively recently that we discovered very fascinating materials, *i.e.*, various nanowires encapsulated carbon nanotubes (cf.Fig.1). We found that nanowires (whose size varies from single-chain nanowires to several hundreds-chain nanowires depending upon the diameter of host carbon nanotubes) can easily be fabricated during a high-temperature annealing of simple aromatic hydrocarbons. This is the first example that pure nanowires of various sizes are prepared within carbon nanotubes, in which electronic and magnetic properties are expected to exhibit some unique properties such as ferromagnetism and superconductivity due to substantial charge transfers between nanowires and carbon nanotubes.

【Research Methods】

Of the most important targeted goals of the present projects is not only to fabricate the present novel nano-carbon materials but to characterize them in terms of simultaneous measurements of structures and electron

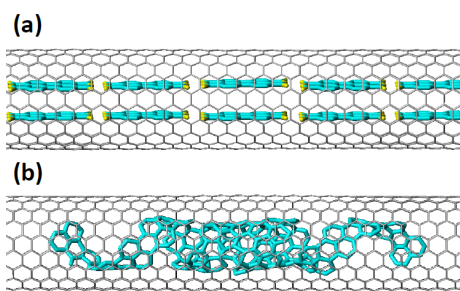
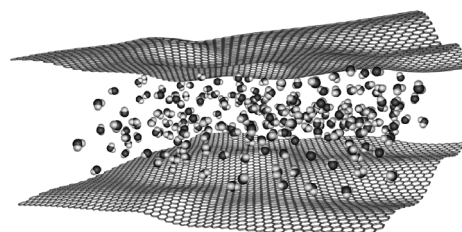


Fig. 1 Inner space

transport properties. This can only be realized by a specially designed technique where HRTEM, FET and Raman spectroscopy measurements are performed on exactly the same individual nano-peapod and/or nanowires carbon nanotubes. Furthermore, by using the two-dimensional space between two layers of graphene, one can “sandwich” nanomaterials in two-dimensional fashion (Fig.2). In addition, the present project investigates also the

development and fabrication of such a combined experimental set-up.



【Expected Fig.2 2D-Inner space

【Research Achievements and Scientific Significance】

By using the present experimental techniques, we are able to fabricate both one- and two-dimensional brand-new nanomaterials within carbon nanotubes and between the two layers of graphene, respectively.

【Publications Relevant to the Project】

- “Template Synthesis of Linear-Chain Nano-diamonds inside Carbon Nanotubes” Y.Nakanishi *et al.* *Angew.Chem.Int.Ed.* **54**, 10802-10806 (2015).
- “Core-Level Spectroscopy to Probe the Oxidation State of Single Europium Atoms” L.H.G.Tizei *et al.* *Phys.Rev.Lett.* **114**, 197602-1-5 (2015).

【Term of Project】 FY2016-2020

【Budget Allocation】 108,200 Thousand Yen

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