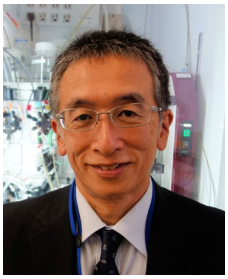
【Grant-in-Aid for Scientific Research (S)】

Broad Section D



Title of Project： Creation and application of perfect structure carbon nanotubes

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Research Project Number: 20H05668 Researcher Number：30194757

Keyword：Carbon nanotube, Structure sorting, Healing

【Purpose and Background of the Research】

Carbon nanotubes (CNTs) were discovered in Japan in 1991 as multi-walled and in 1993 as single-walled. Single-wall CNTs are tubular structures with a diameter of about one nanometer made of a single atomic layer carbon. Due to their excellent physical and electrical properties, it is expected to be applied in various fields including electronic devices. In order to achieve this, our previous work has enabled the automatic sorting of 20 different structure single-wall CNTs from as grown mixture. By combining with the mass CNT synthesis method, it has become possible to easily obtain single-wall CNTs with controlled structures, but enough performance has not yet been obtained for practical use. In recent years, it has become clear that one of the causes is "defects". Single-walled CNTs are composed of a network (network) in which carbon atoms are covalently bonded and have a structure in which all atoms are located on the surface. It is not easy to build this network perfectly, and the single-wall CNTs currently available contain many defects. The purpose of this research project is to create CNTs that do not contain "defects" and to bring out the original excellent physical properties of CNTs.

【Research Methods】

In this research, we will utilize a new technology that can separate low-defect CNTs simply by pouring them into a column (see Fig. 1). With this technology, it is possible to

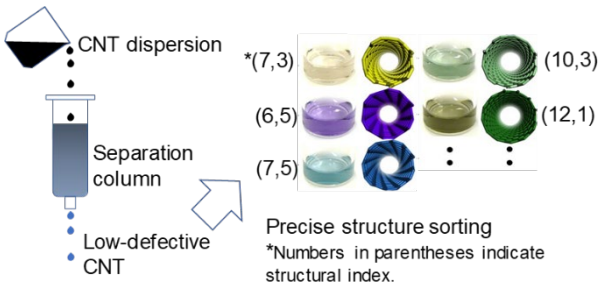

Figure 1 Separation of CNTs

sort low-defect CNTs and quantitatively investigate the defect density distribution of raw CNTs. By thermally and chemically treating the raw material CNT, it is possible to precisely investigate how much defect repair has progressed. Using this high-sensitivity defect detection method, we will try to heal CNT defects, which was difficult until now. We aim to realize perfect structure CNTs by selecting those with low defects from them.

【Expected Research Achievements and Scientific Significance】

The research results of CNTs obtained so far have been for CNTs containing many defects. By eliminating defects, it will be possible to bring out the amazing physical properties of CNTs, and rapid application development such as electronic devices is expected. As a high luminous efficiency fluorescent material in the near infrared region with high bio permeability, it can be expected to be applied to pathological research by bioimaging.

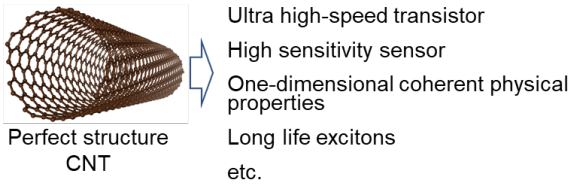

Figure 2 Research and application of perfect CNT

【Publications Relevant to the Project】

- Y. Yomogida *et al.* “Industrial-scale separation of high-purity single-chirality single-wall carbon nanotubes for biological imaging”, Nat. Commun. **7**, 12056 (2016).
- X. Wei *et al*. “Experimental determination of excitonic band structures of single-walled carbon nanotubes using circular dichroism spectra”, Nat. Commun. **7**, 12899 (2016).
- H. Liu *et al*. “Large-scale single-chirality separation of single-wall carbon nanotubes by simple gel chromatography”, Nat. Commun. **2**, 309 (2011).

【Term of Project】 FY2020-2024

【Budget Allocation】 151,300 Thousand Yen

【Homepage Address and Other Contact Information】

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