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創発的研究支援事業　年次報告書

研究担当者	湯　代明
研究機関名	国立研究開発法人物質・材料研究機構（NIMS）
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研究課題名	CNT molecular junction based THz electromechanical systems/カーボンナノチューブ分子接合型テラヘルツ電気機械システムの開発
研究実施期間	2023 年 4 月 1 日～2024 年 3 月 31 日

研究成果の概要

Nano- electromechanical systems (NEMS) are the foundation of measurement and sensors in classical and quantum information technologies. In this project, carbon nanotube (CNT) molecular junctions are explored as a hybrid 0D-1D electromechanical system with the resonating frequency approaching THz region. The project includes precise fabrication, atomic characterization, and electromechanical measurement of the carbon nanotube molecular junction devices.

In 2023, progresses were made in (1) growth of CNTs by using chemical vapor deposition (CVD) method (Fig. 1a-b); (2) fabrication of CNT molecular junctions by in situ TEM (Fig. 1c). Specifically, a CVD furnace is setup. By optimizing experimental conditions, such as temperature and precursors, growth of aligned CNTs with length up to millimeter has been realized. In addition, CNTs have been grown on MEMS chips and on metal substrates, which are compatible with nanofabrication and in situ TEM observations. To fabricate CNT junctions in a controllable manner, in situ TEM observations were conducted on structural changes of CNTs under electron irradiation. Adjusting electron energy and temperature, CNT junctions were fabricated with the junction length down to 1 nm. In addition, STEM ptychography was applied to analyze the structure of CNT junctions. Detailed atomic structures, including pentagons and heptagons were resolved to reveal the chirality transformation mechanism.

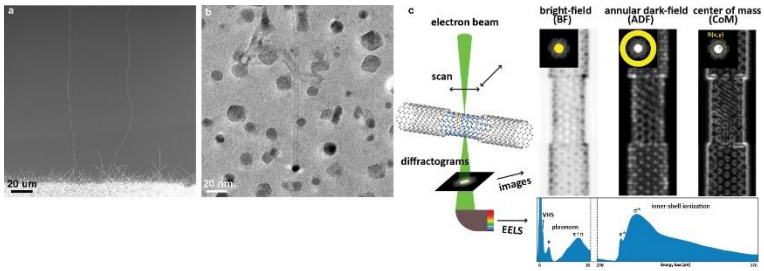

Figure 1. (a-b) Growth of CNTs; (c) Fabrication and characterization of CNT junctions (Tang *et al.*, *Nature Reviews Electrical Engineering* **1**, 149-162 (2024)).