Direct Determination of Optical Isomers for Carbon Nanotubes

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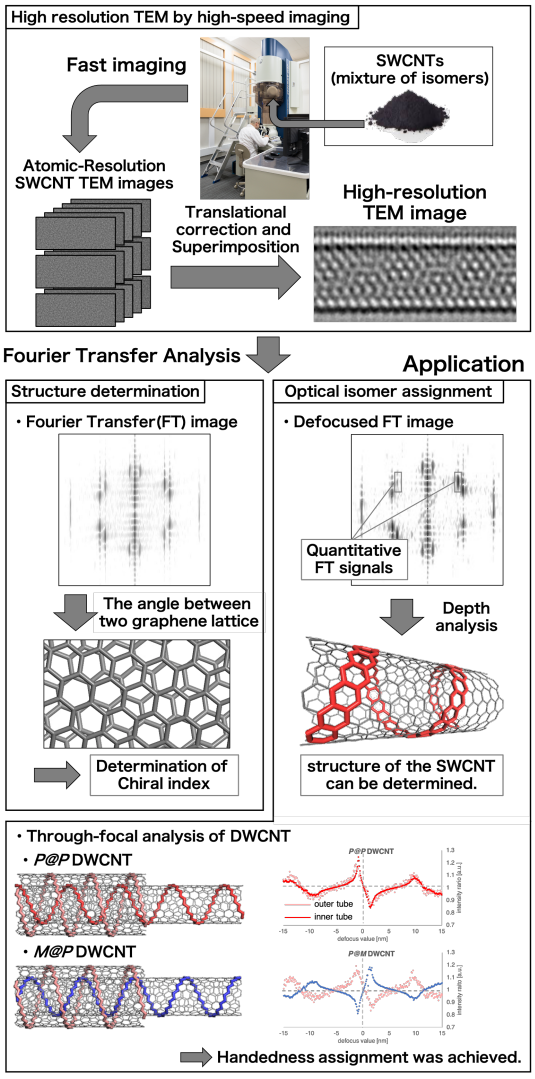
Keywords: Transmission Electron Microscopy; Carbon Nanotube; Through-focal imaging; Absolute Configuration; Three-dimensional Structure Analysis

Almost all the nanomaterials and molecules have three-dimensional (3D) information, and the structure is closely related to the physical properties. Although atomic resolution microscopy is known as the only method to directly determine the structure, there is no technique with atomic depth resolution. Though the most general method to obtain out of the plane information is rotation, this rotation method has many technical constraints, and the application for the single nanomaterials has not come to the realization yet. There is a need for a new tomography method without any mechanical specimen movement to overcome the problem. In principle, since the information out of the plane is included in the phase contrast of TEM, it is possible to extract the three-dimensional structure. However, since this method involves considerable difficulty, only a few simplified and modeled examples[1,2] were reported.



Herein, we demonstrate a direct determination method for the optical isomer of individual carbon nanotubes (CNTs) without any specimen movement by utilizing fast TEM video imaging and image processing. Improvement of signal intensity originating in graphene lattices[3] by computational motion correction between each frame in the TEM video allows us to determine not only structure (i.e. chiral index) but also relative orientation of top and bottom graphene layers of CNTs and thus optical isomerism.

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