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カーボンナノチューブからグラフェンナノリボンへ

Transforming Carbon Nanotubes into Graphene Nanoribbons

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Abstract

We have fabricated flattened carbon nanotubes, Graphene nanoribbon (GNR), using solution-phase extraction of inner tubes from large-diameter multi-wall CNTs (MWNTs). Arc-grown MWNTs were first oxidized in air at 700℃ to remove impurities and etch the surface of MWNTs. The extraction of inner tubes was carried out by vigorous dispersion of MWNTS in H_2O with 1% sodium cholate hydrate (SC). After ultracentrifugation, the obtained supernatant solution contains many flattened CNTs, and we found that approximately 80% of MWCNTs provide flattened CNTs of high quality and purity.

1. Introduction

The graphene nanoribbon(GNR) is one of the most promising candidates for the fabrication of nano-electronic devices such as thin-film transistors of very high-mobility [1,2]. Lithographic and chemical methods have been used to produce GNRs from few layers graphene and unzipping of carbon nanotubes(CNTs). However, only few amounts of GNRs have so far been produced by using previous methods which entail structure defects on GNRs. Here, we report a novel high-yield fabrication method of another type of GNRs: fully flattened CNTs [2,3] using solution-phase extraction of inner tubes from large-diameter multi-wall CNTs (MWNTs).

2. Results and Discussion

Our previous study [4] shows that inner CNTs can be efficiently extracted from double-wall CNTs by vigorous sonication with water containing surfactants. Here, we have applied this method to extract 1-3 layers CNTs of large diameter from arc-grown MWNTs for the fabrication of fully flattened CNTs due to its high purity and crystallinity. Solution-phase process was carried out according to the previously reported procedures [2,4]. The obtained solution contains many GNRs, and we found that approximately 80% of MWCNTs provide GNRs of high quality and purity.

Figure 1 shows typical low-magnification TEM images of fully flattened CNTs extracted, which clearly show GNR structure with a ribbon width of typically 40nm. The magnified image shows a cross sectional view of a triple layer barbell-like structure, indicating that CNTs are flattened to form GNRs. To the best of our knowledge, this is obviously the first TEM image that clearly shows cross-section of flattened CNTs (GNR). Figure 1 (c) is a typical AFM image and height distribution of GNR corresponding to 4 layer GNRs.

3. Summary

We have succeeded to fabricate GNRs using solution-phase extraction of inner tubes from large-diameter MWNTs. The obtained solution contains many GNRs with approximately 80% yield. Investigation of FET characteristics and detailed structural characterization using TEM are currently underway.

4. References

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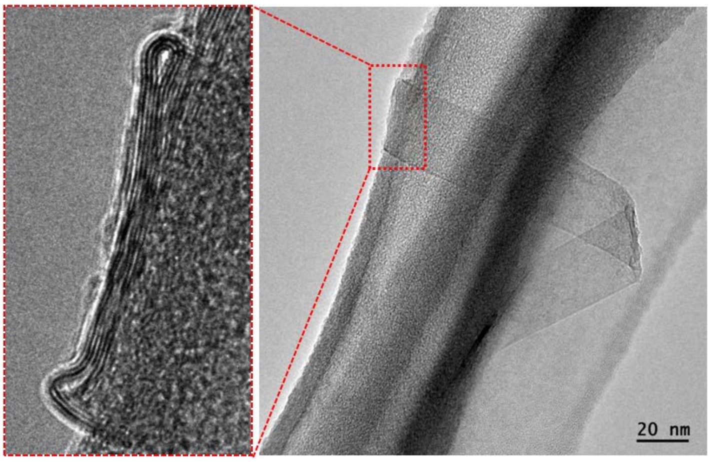

Figure 1. TEM images of flattened CNTs: GNRs

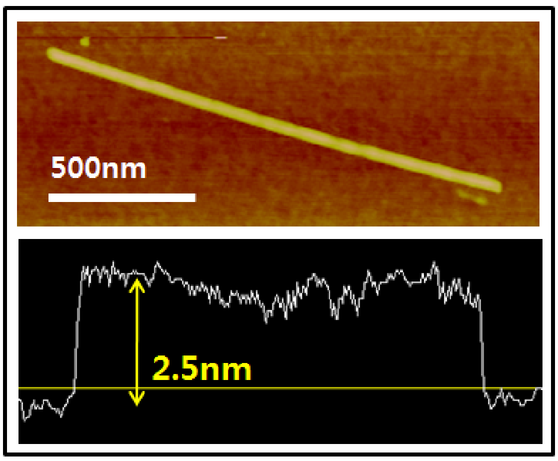

Figure 2. AFM image of flattened CNTs