Defect engineering of Single-Walled Carbon Nanotubes using Scanning Tunneling Microscopy

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Single Walled Carbon Nanotube (SWNT) is one of the most promising candidates for the material of future electronic devices because of its excellent one-dimensional electronic property. Electronic transport property of SWNT depends not only on their atomic structures, but also on the presence of defects. Therefore, several experimental approaches such as electron beam or plasma irradiation have been applied to introduce defects in SWNT [1].

In this paper, we present a new method which enables us to create and annihilate defects on SWNTs by local carrier injection to using a STM tip. The experiments were performed at 77K and 4K. Samples were prepared by spin-coating of 1-2-dichloroetane dissolved HiPCO SWNTs solvent on a freshly cleaned Au(111) surface.

Figure 1 shows the process of defect creation on a SWNT. After STM imaging of a defect-free SWNT (Fig. 1(a)), carrier injection was applied above the triangle mark in Fig. 1(b), by a tunnel-bias-voltage ramp from -1V to -8V with tunneling current being kept constant (1nA). During the process, a sudden change in the STM tip height was observed due to the change in the electrical current by the defect creation (Fig.1(c)). The STM image obtained after the process shows the appearance of a defect on the SWNT around the triangle mark (Fig. 1(b)). Noteworthy point is that applying voltage ramp in the same way led to annihilation of this defect. This reversible reaction indicates the preservation of the number of carbon atoms during the process, suggesting the Stone-Wales defect (Fig. 2) as a candidate for the structure. The results obtained by STS measurements were consistent with the structural model. Details will be discussed at the colloquium.

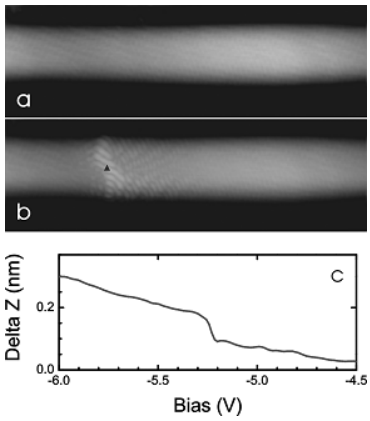

Fig. 1. STM image of a SWNT before (a) and after (b) bias-voltage ramp. (c) Z-V curve measured during the bias-voltage ramp.

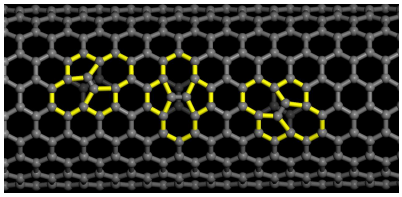

Fig. 2. Structural model of the Stone-Wales defect on a SWNT.

Reference
http://dora.bk.tsukuba.ac.jp/
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[2] M. Berthe et al., Nano Lett., in Press.