Device Fabrication by Using Biologically Functionalized Nanotubes as Building Blocks

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Non-lithographic fabrications of devices such as electronics and sensor have been studied extensively by assembling nanometer-sized building blocks into the device configurations. While various nanocomponents have been applied as building blocks to construct nanodevices, the more reproducible methods to assemble them onto precise positions are desirable. We have been fabricating peptide-based nanotubes.[1] and functionalizing them with various recognition components,[2,3,4] and our strategy is to use protein-functionalized nanotubes (Figure 1), which can recognize and selectively bind a well-defined region on patterned substrates, as building blocks to assemble three-dimensional nanoscale architectures at uniquely defined positions and then decorate the nanotubes with various materials such as metals and quantum dots for electronics and sensor applications.[5,6,7]

In this presentation, we would like to present the nanotube assemblies using biological recognitions. We have demonstrated that the nanotubes can be selectively immobilized on surfaces using protein-protein interactions (Figure 2).[8] Protein immobilization on nanotubes can be limited to the ends of nanotubes by using Au, Ni, and Cu nanocrystals as masks on the sidewalls of nanotubes. Nanotubes are also succeeded to be coated by those nanocrystals with controlled size and distribution in order to tune the conductivity of nanotube. This fabrication was achieved by incorporating sequenced peptides onto nanotubes that specifically mineralize only certain ions (Figure 3).[9] The distribution and size of nanocrystals were controlled by the conformations of the sequenced peptides on nanotubes via pH changes. We will also present a method to bundle those nanotubes for the microscopic orgamization.[10]

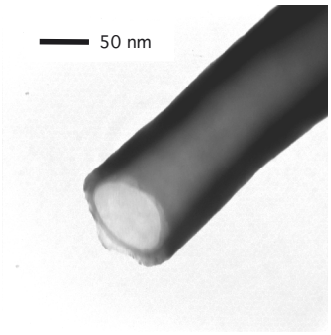


Figure 1. TEM image of the individual protein nanotube. [H. Matsui, S. Pan, B. Gologan, and S. Jonas, *J. Phys. Chem. B.*, **104**, 9576 (2000).

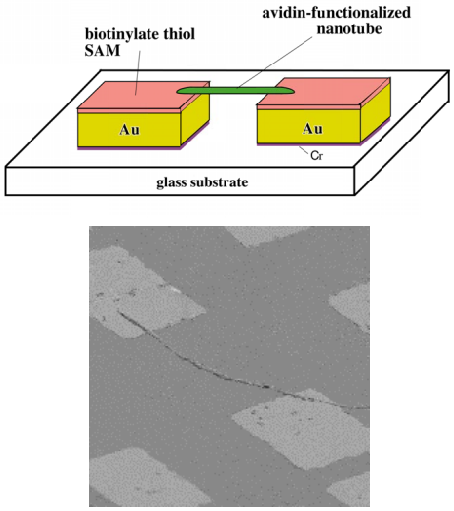


Figure 2. Immobilization of the avidin-coated nanotube on biotinylated thiol-SAM/Au surfaces. [Matsui, H.; Porrata, P.; Douberly, G. E, Jr., *Nano Lett.* **1**, 461, (2001)].

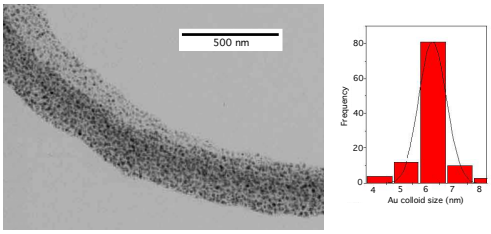


Figure 3. (left) TEM image of Au nanocrystals on the nanotube coated with the sequenced histidine-rich peptide. (right) Size distribution of Au nanocrystals on the nanotube. [Djalali, R.; Chen, Y-F.; Matsui, H., *J. Am. Chem. Soc.*, **124**, 13660 (2002)]

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