Selective Carbon Nanotubes Growth on Silicon Tips with the Soft Electrostatic Force Bonding and Catalyst Transferring Concepts

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Carbon nanotubes, which has unique sharpness, high aspect ratio, high mechanical stiffness, and resilience, is an ideal and specific material for use as scanning probe tips. The long, narrow geometry of the nanotubes could be allow probing of high-aspect-ratio structures, and has been proved to be highly durable and enable high-resolution imaging and lithography [1]. In most research, carbon nanotubes as scanning probe tips are resulted from manual attachment of a nanotube to a pyramidal tip of silicon cantilever [2]; however, manual attachment is a time-intensive process and its reproducibility would be a serious problem. In this research, a method of selective carbon nanutubes growth on silicon tips with specific catalyst transferred concept would be described.

To integrate a single nanotube onto silicon tips, the area of deposited catalyst on the apex of silicon tips influences the quantities of growth carbon nanotubes. Therefore, a method of selective carbon nanotubes growth with soft electrostatic force bonding and catalyst transferring concepts, to reduce the area of deposited catalyst, has been evaluated here. In this technique, the 100-angstrom nickel catalyst was deposited onto a flat sodium ion rich glass wafer as shown Fig. 1. The glass wafer with catalyst deposited side was covered slightly against a silicon substrate containing the silicon pyramidal tips arrays. When an additional negative voltage applied on the glass, the electrostatic force would be occurred and soft bonded in the tiny contact area between glass and silicon tips. Subsequently, removed the glass and the silicon substrate with catalyst transferred tips was subjected to methane CVD to growth carbon nanotubes.

The preliminary result of multi-walled carbon nanotube (MWNTs) is shown in Fig, 2. The oriented MWNTs were observed on roughly 10 percent of the silicon tips. The yield could be further increased by optimizing the silicon tip structure, contact force of soft bonding pressure, and improving the catalyst deposition process in the near future.

Reference:

[1] S. Wong, A. Wooley, E. Joselevich, and C. Lieber, “Functionalization of carbon nanotube AFM probes using tip-activated gases,” Chem. Phys. Lett., **306**, 219-225 (1999).
[2] H. Dai, J.H. Hafner, A. G. Rinzler, D.T. Colbert, and R.E. Smalley, “Nanotubes as nanoprobes in scanning probe microscopy,” Nature **384**, 147-150 (1996).

Figures:

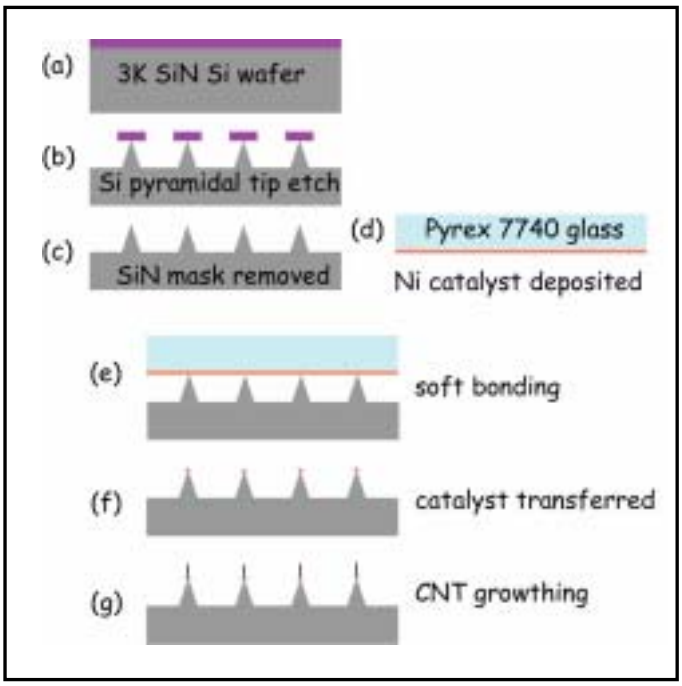

Figure 1. Process flow for fabricating array of carbon nanotube pyramidal tips.

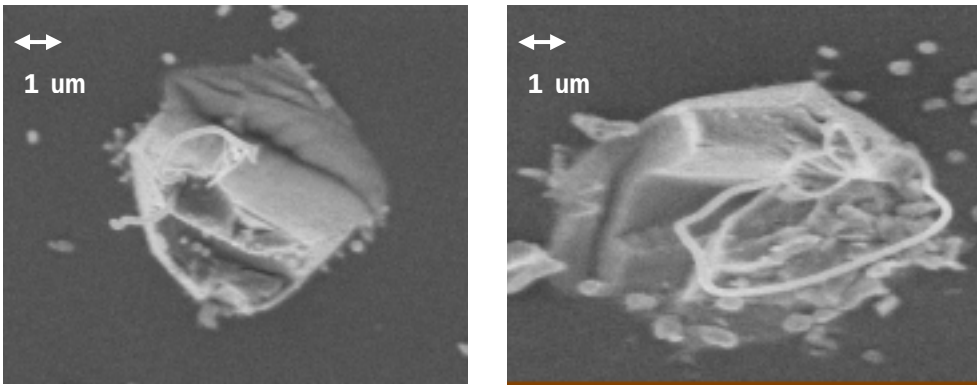

Figure 2. SEM micrograph of MENT on silicon pyramidal tips.