

Single-walled carbon nanotubes for biological applications

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Abstract

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Carbon nanotubes for biological applications

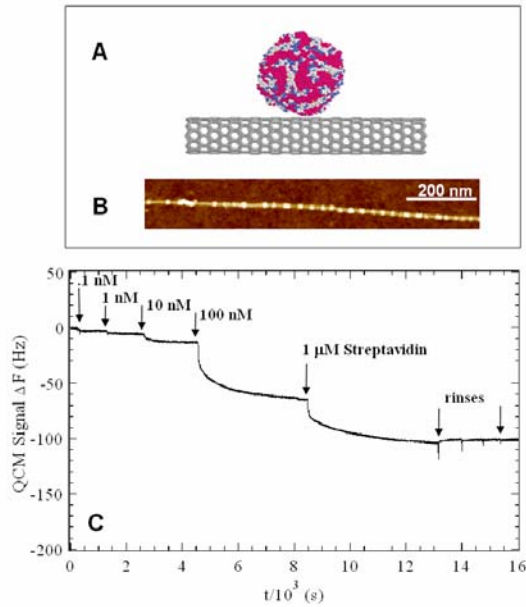
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Controlled synthesis of nanoscaled materials and intensive studies about their unique electronic, optical, mechanical and surface chemical properties have triggered rigorous efforts for the applications such as nanoelectronics, nano-optoelectronic devices, nanoelectromechanical system (NEMS), etc. Recently, nanoscale materials for biological applications such as DNA chip, quantum dot as a fluorescence tag, electrical protein, DNA sensor devices are at the center of interests taking advantages of sizes, efficient optical properties as well as unique electrical properties. In this presentation, recent progresses in carbon nanotube based field effect transistor for electrical biosensor devices as well as hybrid biosensor system composed of single walled carbon nanotube films as nano-platform for efficient immobilization of protein molecules and conventional fluorescence technique as a detection method will be discussed.

Non-specific interaction of SWNT with proteins

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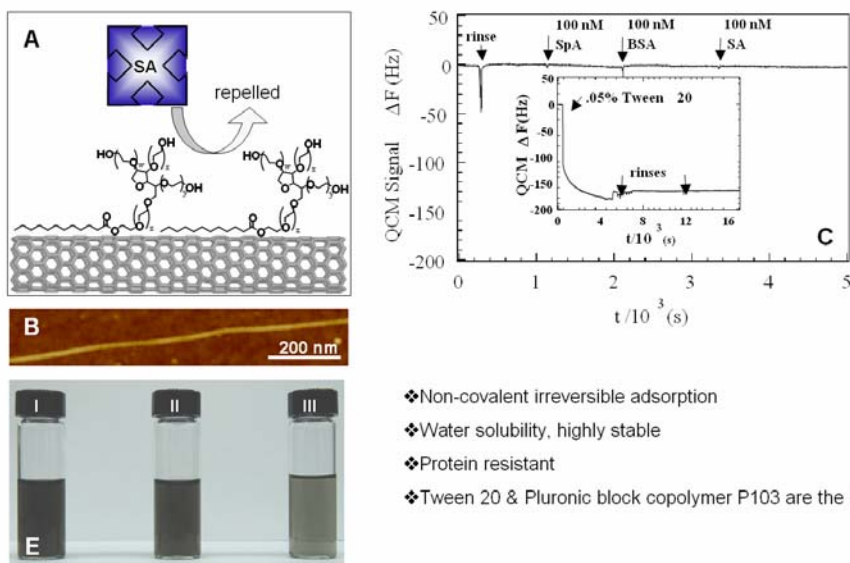


Turns out to be generic:
Streptavidin, Protein A,
Glucosidase, Bovine
Serum Albumin, IgG...

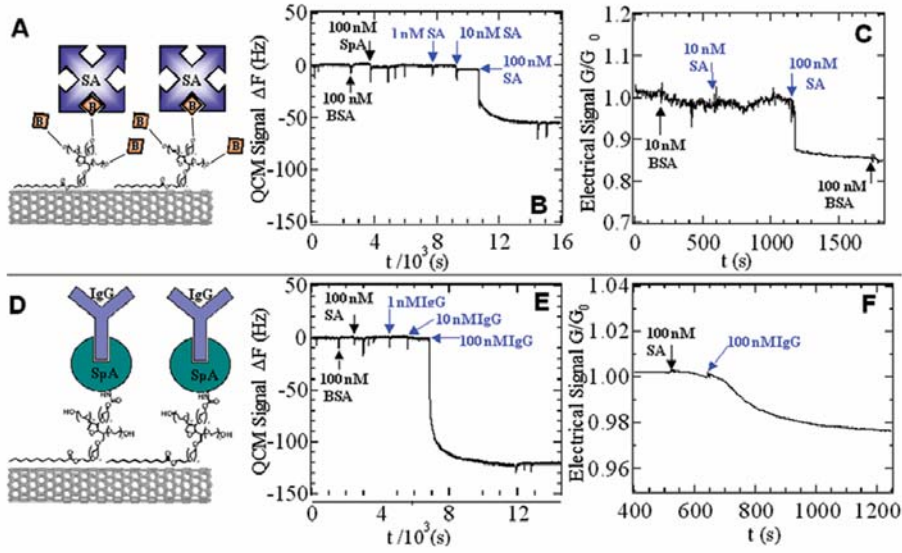
Chen et al, *PNAS* 2003, 100, 4984

Hydrophobic/vdW anchoring of Tween20/PEG

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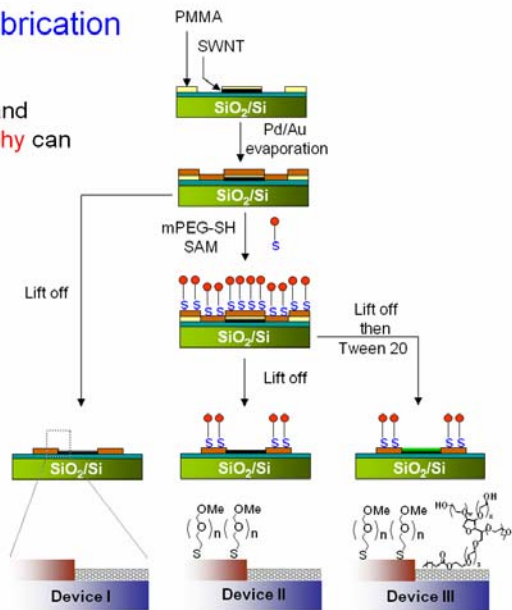


- ❖ Non-covalent irreversible adsorption
- ❖ Water solubility, highly stable
- ❖ Protein resistant
- ❖ Tween 20 & Pluronic block copolymer P103 are the best



CNT-FET device fabrication

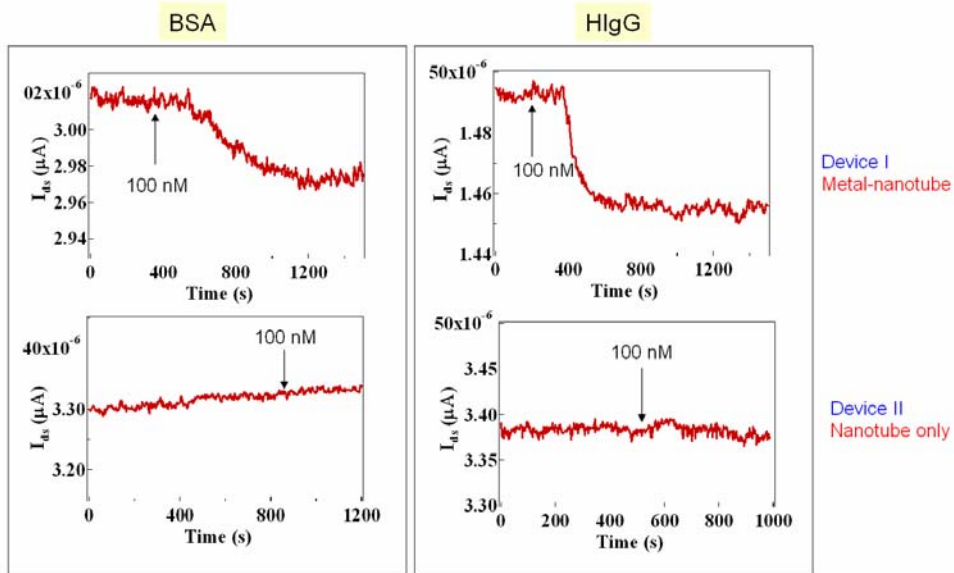
Both photolithography and electron-beam lithography can be used



Chen, Choi et al *J. Am. Chem. Soc.* **2004**, 126, 1563

Nanotube vs. metal-nanotube contact

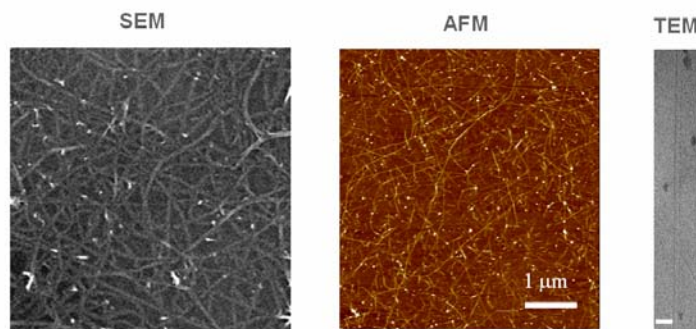
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High yield SWNT for protein immobilization

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How about carbon nanotubes?

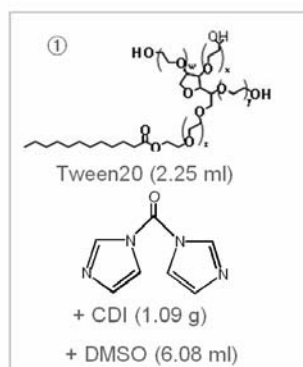


Nanotube strings formed as a pseudo-3D structures
: providing minimum contact surface area

Choi, H. C. et al., *Nano. Lett.* 2003, 3, 157.

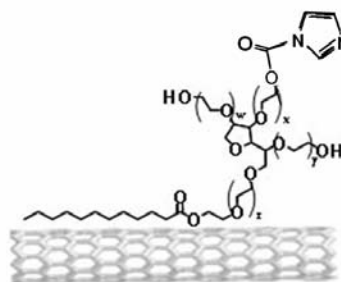
Non-covalent functionalization of SWNT

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SWNT modified with CDI*-Tween20 as blocking reagent & covalent bonding with protein

④ *in vacuo*
overnight



CDI-Tween20 on SWNT film**
(imidazolyl carbamate)

② heating 40 °C for 2 h

ethyl ether

③ yellow precipitation

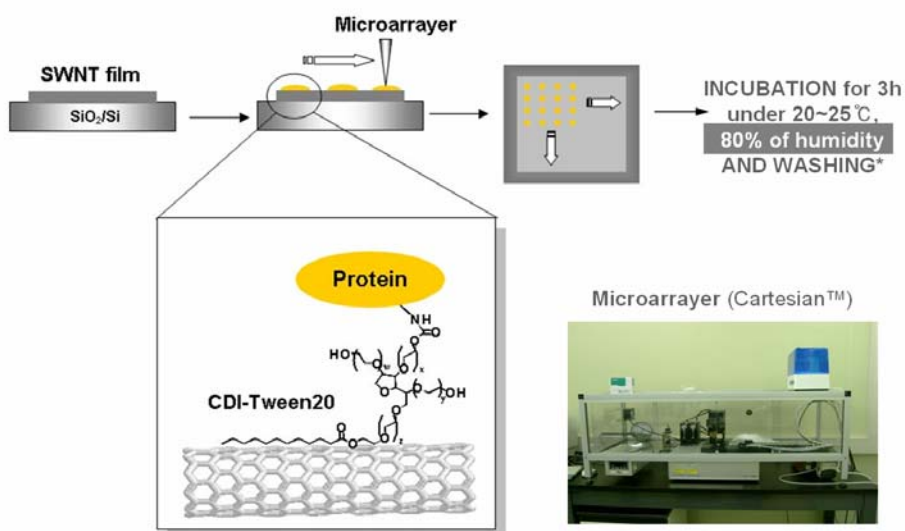
* 1,1'-carbonyldiimidazole

** CDI-Tween20 solution (1wt% in water) soaked SWNT film

Chen, et al, PNAS 2003, 100, 4984

Probe protein spot arrays formed using microarrayer

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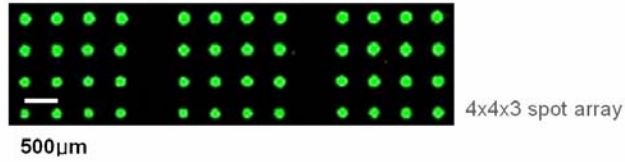
* with PBS (Phosphate Buffered Saline) buffer, pH=7.4 and DI water for 1m

Reproducible formation of microspots

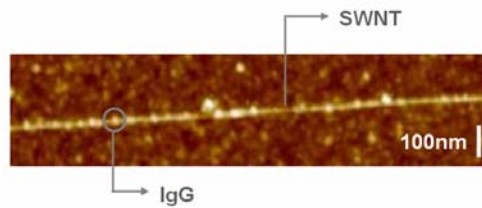
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CDI-Tween20/SWNT film + Cy3-IgG**

- Microarray & laser scanner



- AFM

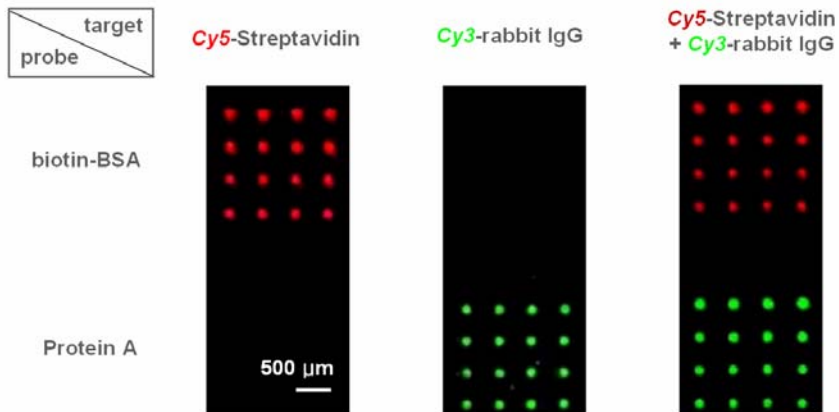


* SWNT + CDI-Tween20
 ** rabbit anti-mouse Immunoglobulin G

Byun et al, submitted (2004)

Specific binding and cross-reactivity

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		Target Protein*		
		Cy5-Streptavidin	Cy3-rabbit IgG	Cy5-Streptavidin + Cy3-rabbit IgG
Probe	biotin-BSA	biotin-Streptavidin	no binding	biotin-Streptavidin
Protein*	Protein A	no binding	Protein A-rabbit IgG	Protein A-rabbit IgG

Byun et al, submitted (2004)

Dual function of Tween20 (self-quenching)

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- Outside the spot

