

# Carbon Nanotubes as a Nanoplatfrom: 1D-0D Heterocomposites and Nanobiosensors

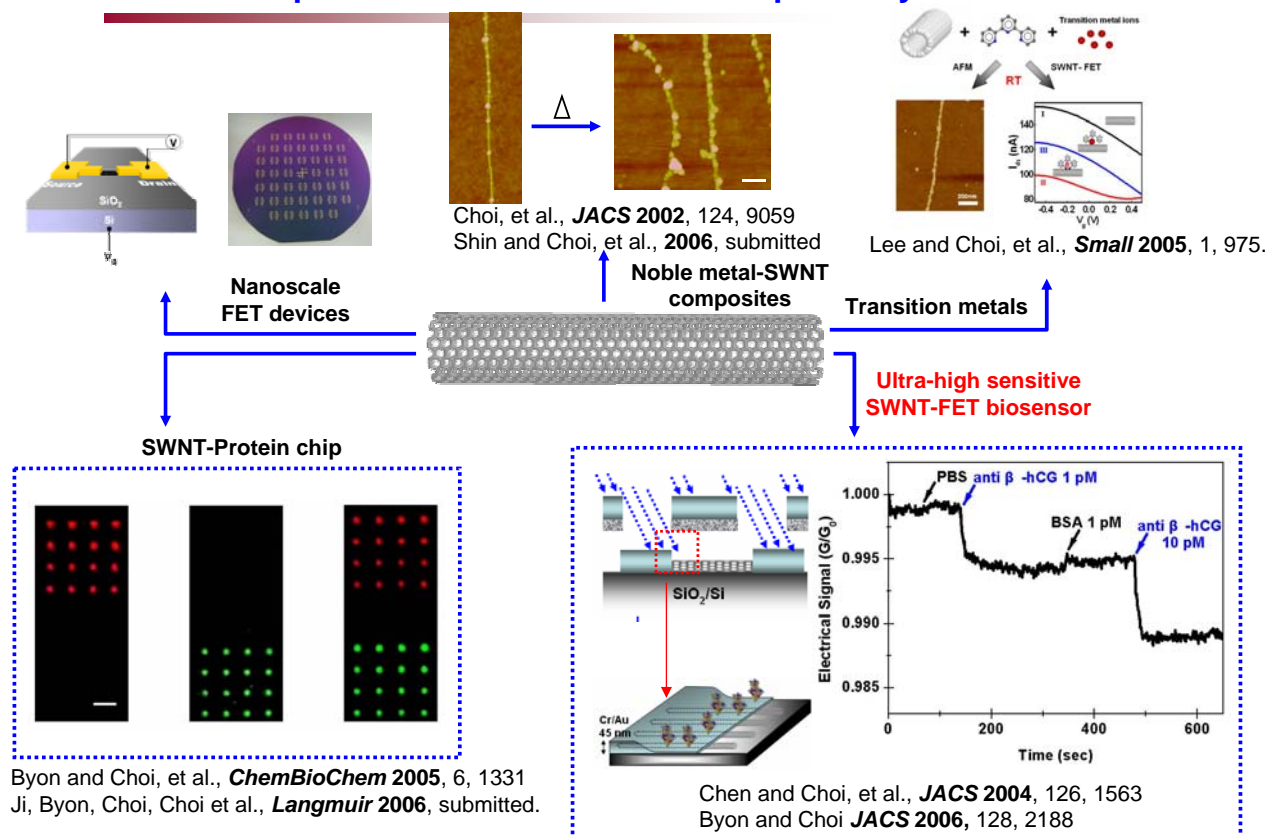
Hee Cheul Choi

Department of Chemistry,  
Pohang University of Science and Technology

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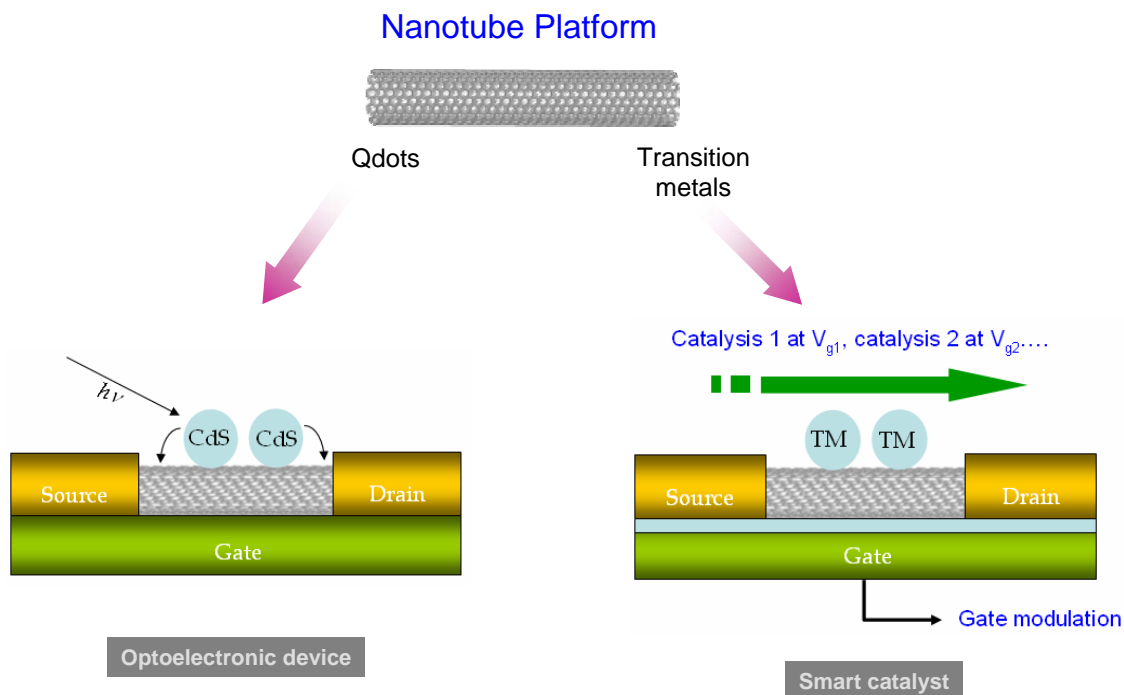
## Carbon nanotube platform for bio- and nanocomposite systems



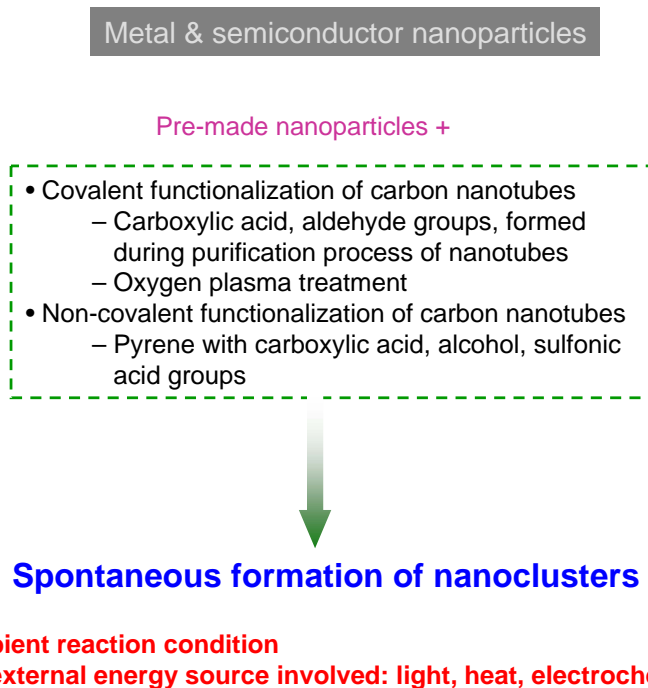
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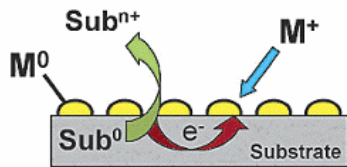
## Nano-hybrid junction systems using carbon nanotubes



## Chemical approaches for the formation of quantum species on carbon nanotubes

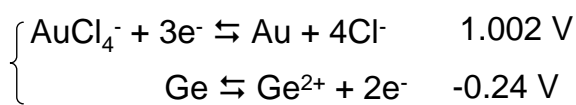
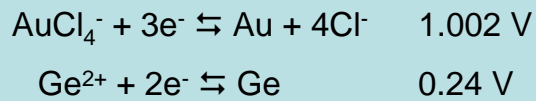


## Electroless deposition for spontaneous formation of quantum dots

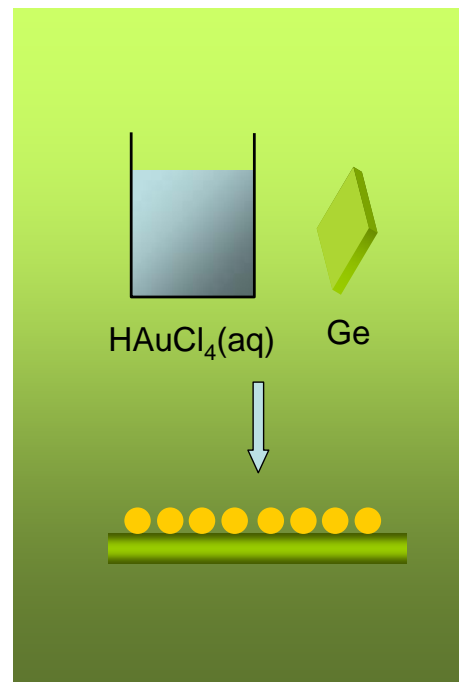


### Galvanic Displacement

#### Au and Ge



$$\Delta E = +0.762 \text{ V}$$

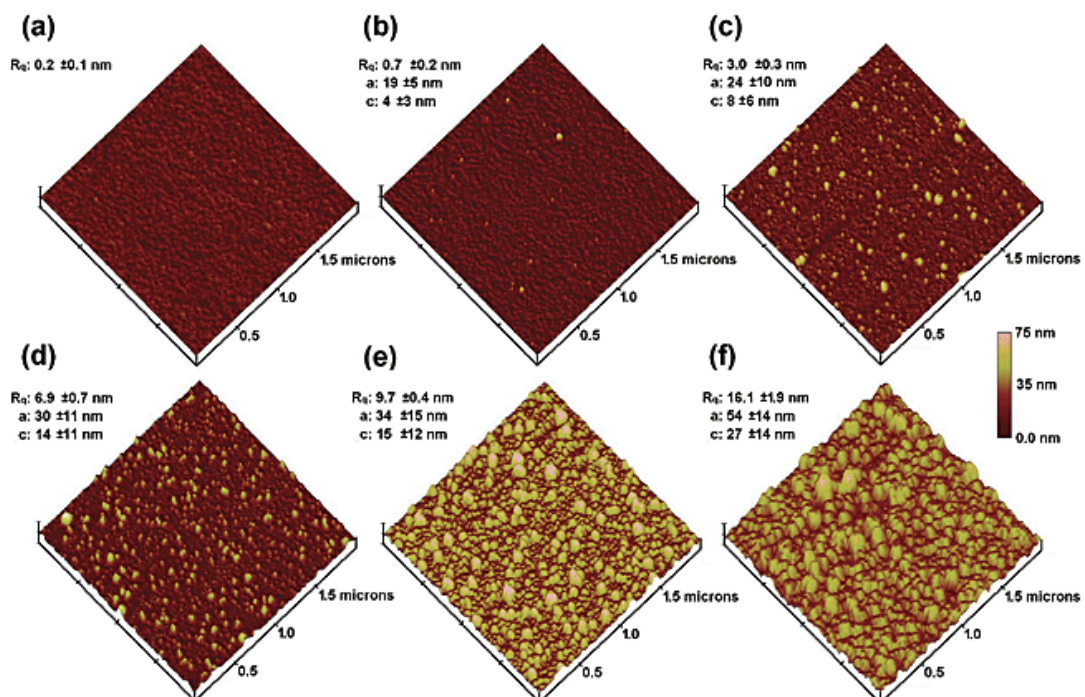


Choi, H. C. Ph.D Thesis, Purdue University 2001

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## Formation of Au Nanoparticles on Ge(100)



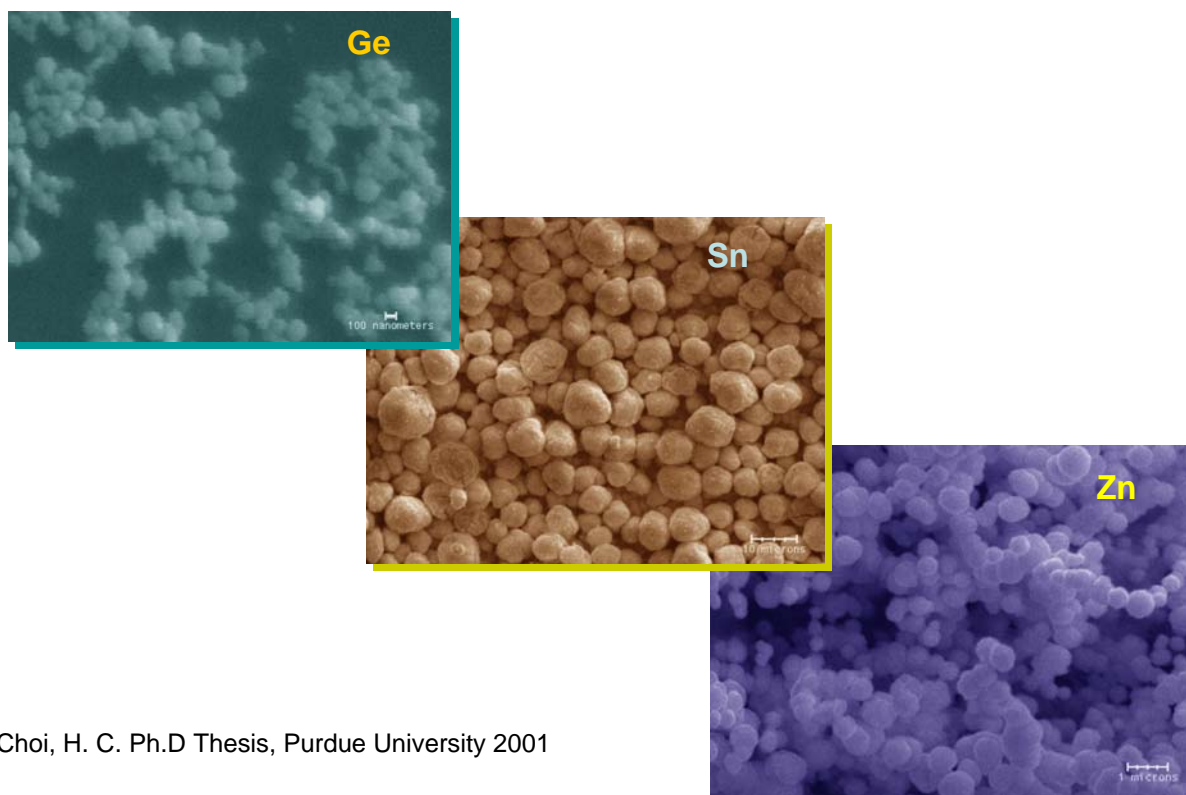
L. A. Porter, H. C. Choi, A. Ribbe, J. M. Buriak *Nano Letters* **2002**, 2, 1067.

H. C. Choi Ph. D. Thesis 2002, Purdue University

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## Spontaneously formed Pt nanoparticles on various metals

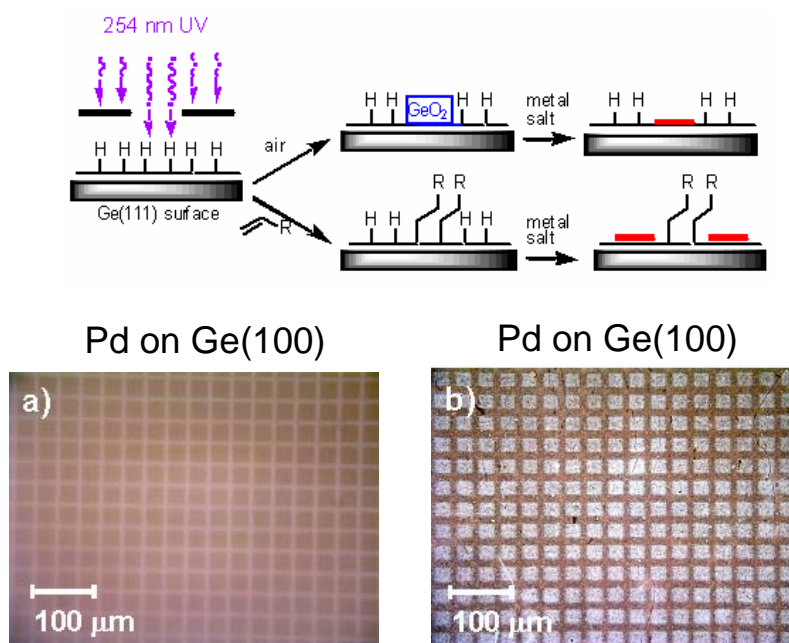


Choi, H. C. Ph.D Thesis, Purdue University 2001

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## Facile nanopattern formation by surface photochemistry



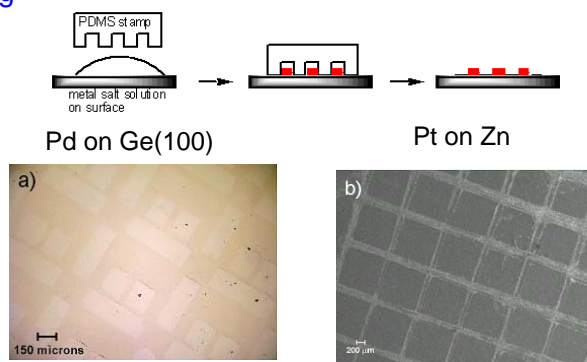
L. A. Porter, H. C. Choi, A. Ribbe, J. M. Buriak *Nano Letters* **2002**, 2, 1369.

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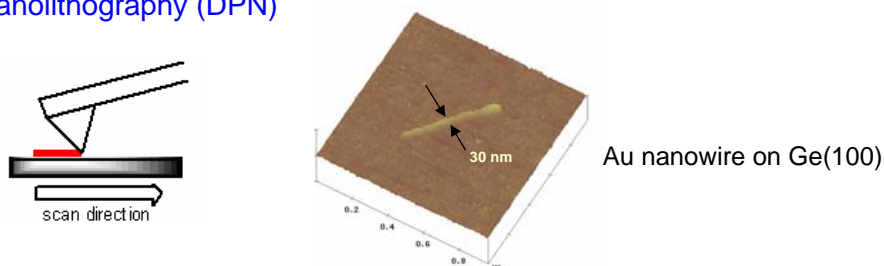
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# Facile nano & micro-pattern formation by electroless metal deposition reaction

## $\mu$ -Contact Printing



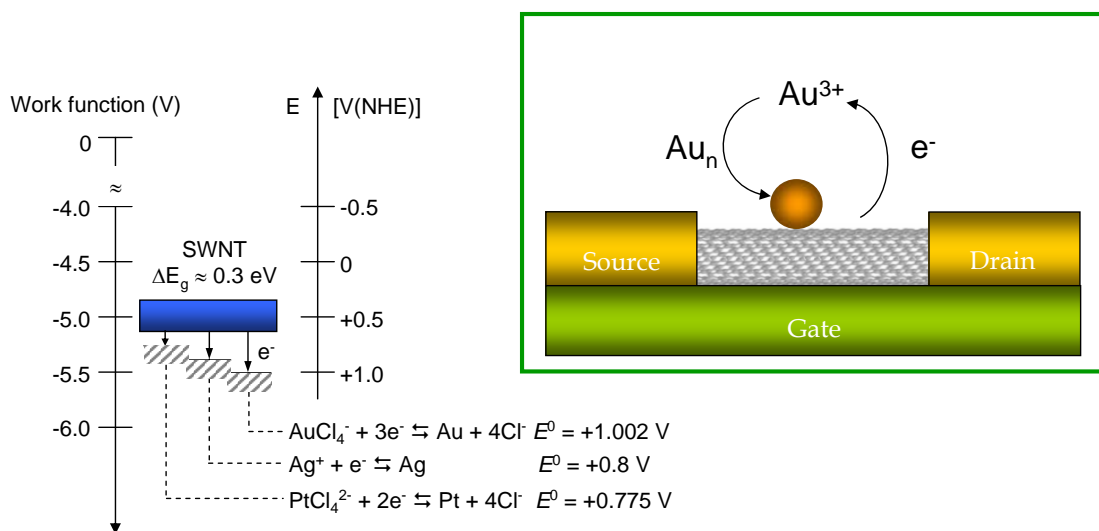
## Dip-Pen Nanolithography (DPN)



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# Noble Metal Quantum Dots on Carbon nanotubes

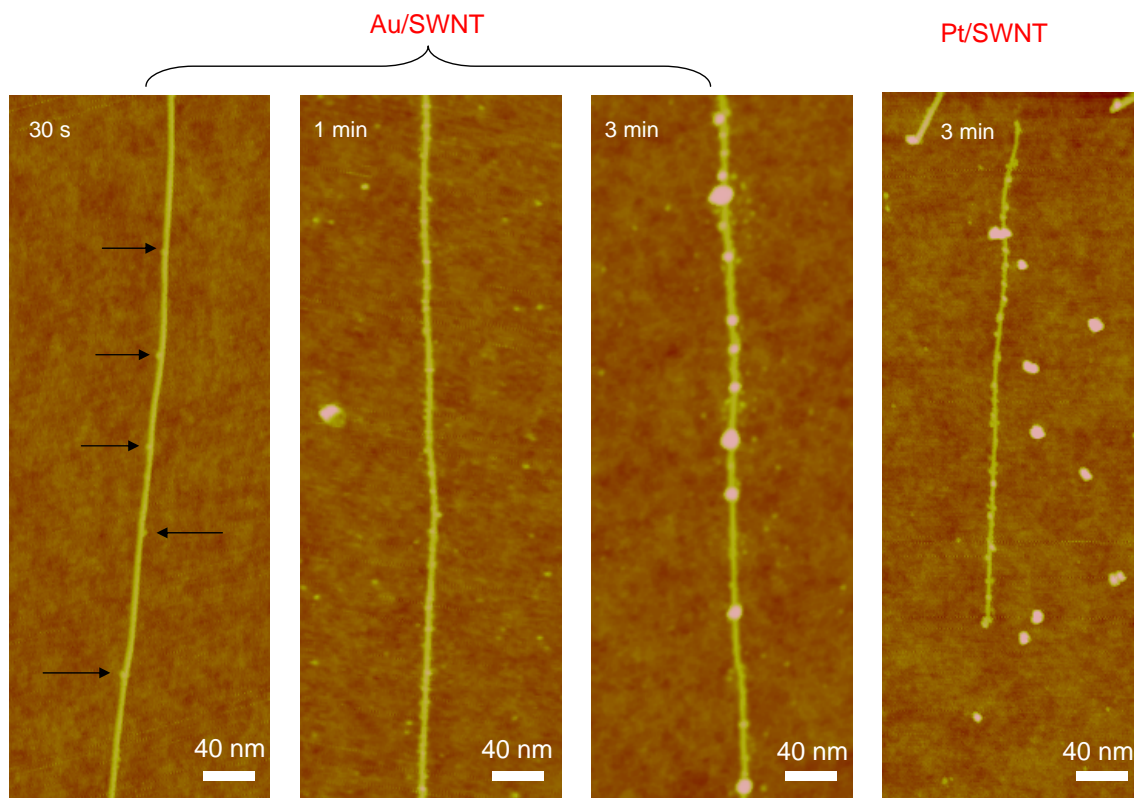


H. C. Choi, M. Shim, S. Bangsaruntip, H. Dai *JACS* **2002**, 124, 9059.

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## Au and Pt Quantum Dots on Carbon nanotubes

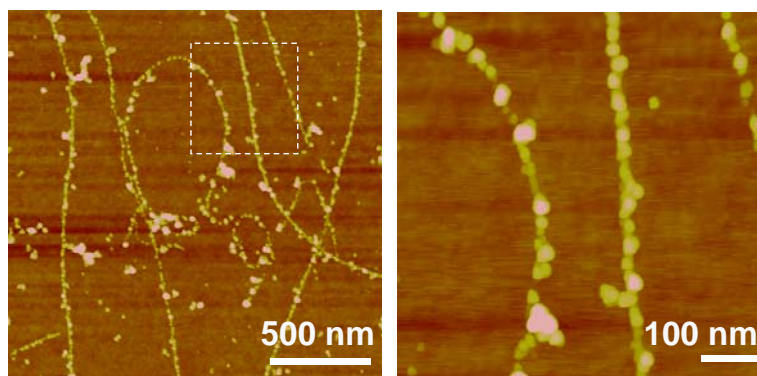


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## Wires of Noble metal Quantum Dots

### Carbon nanotube as a template

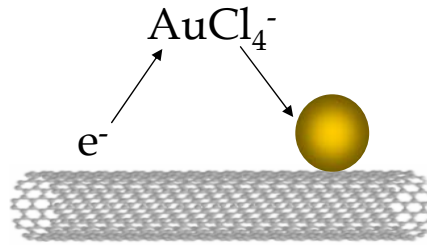


H. C. Choi, M. Shim, S. Bangsaruntip, H. Dai *JACS* **2002**, *124*, 9059.

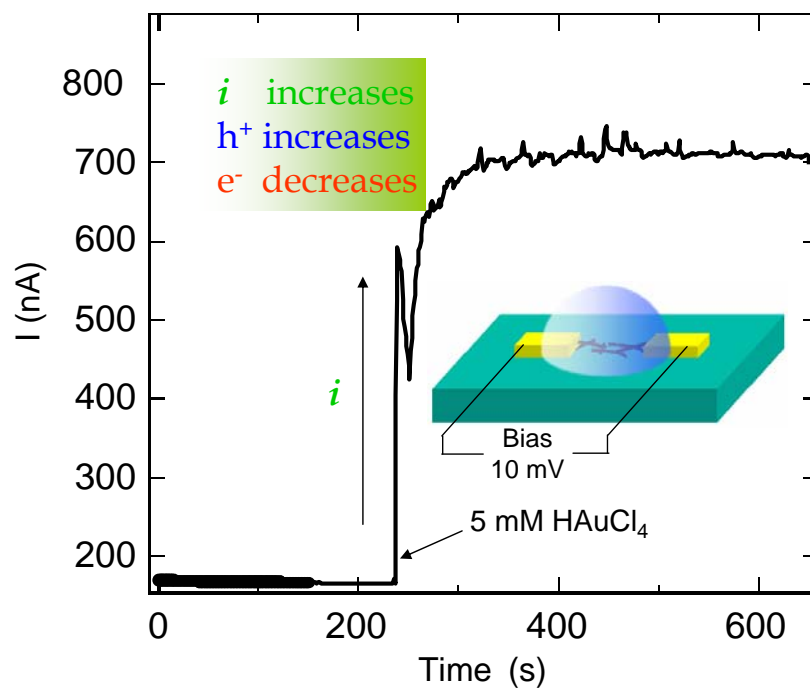
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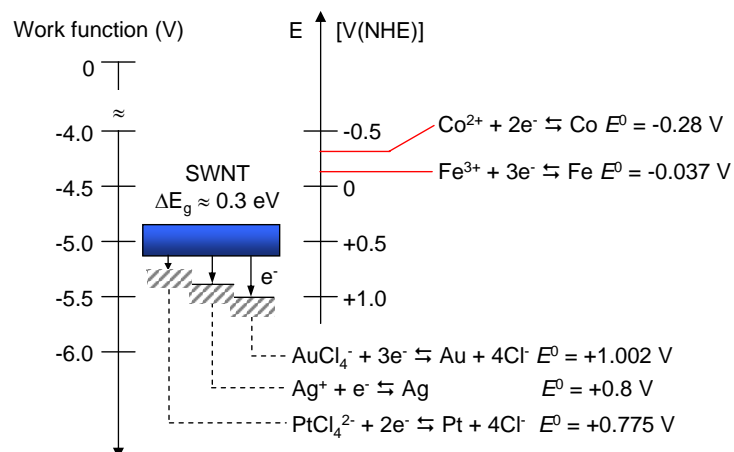
## Hole injection process



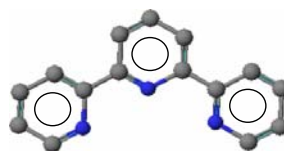
## Electrochemical evidence for the hole consumption



## Transition metal nanoparticles on Carbon nanotubes



## Anchoring Molecules



2,2':6',2'' – terpyridine (Terpy)

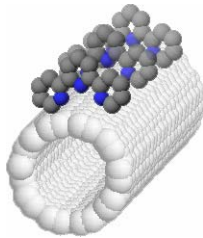
- ◆ Terpyridine is one of the most popular ligands for organometallic complexes. (c.f. Bipy-2,2'-bipyridine)
- ◆ Terpyridine is friendly to both nanotube and transition metal ions due to their structural and electronic properties.
- ◆ Convenient to deal: air stable, soluble in most of alcohols, and most of all, commercially available.



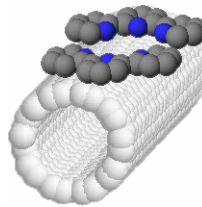
## Functionalization of SWNT with Terpy



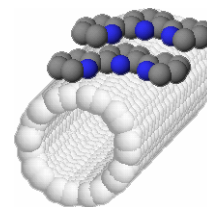
2,2':6',2'' – terpyridine (Terpy)



I



II

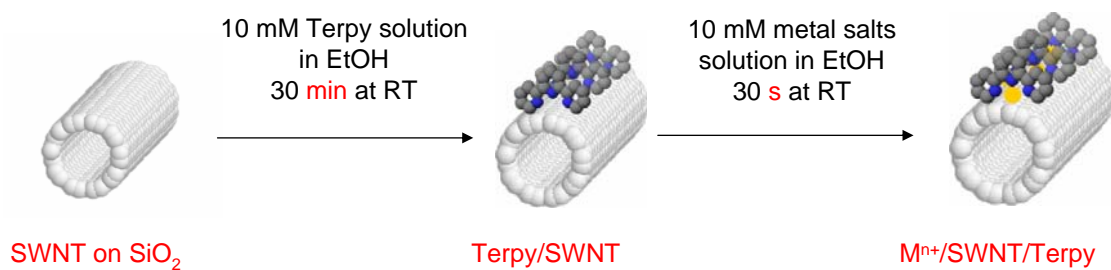


III

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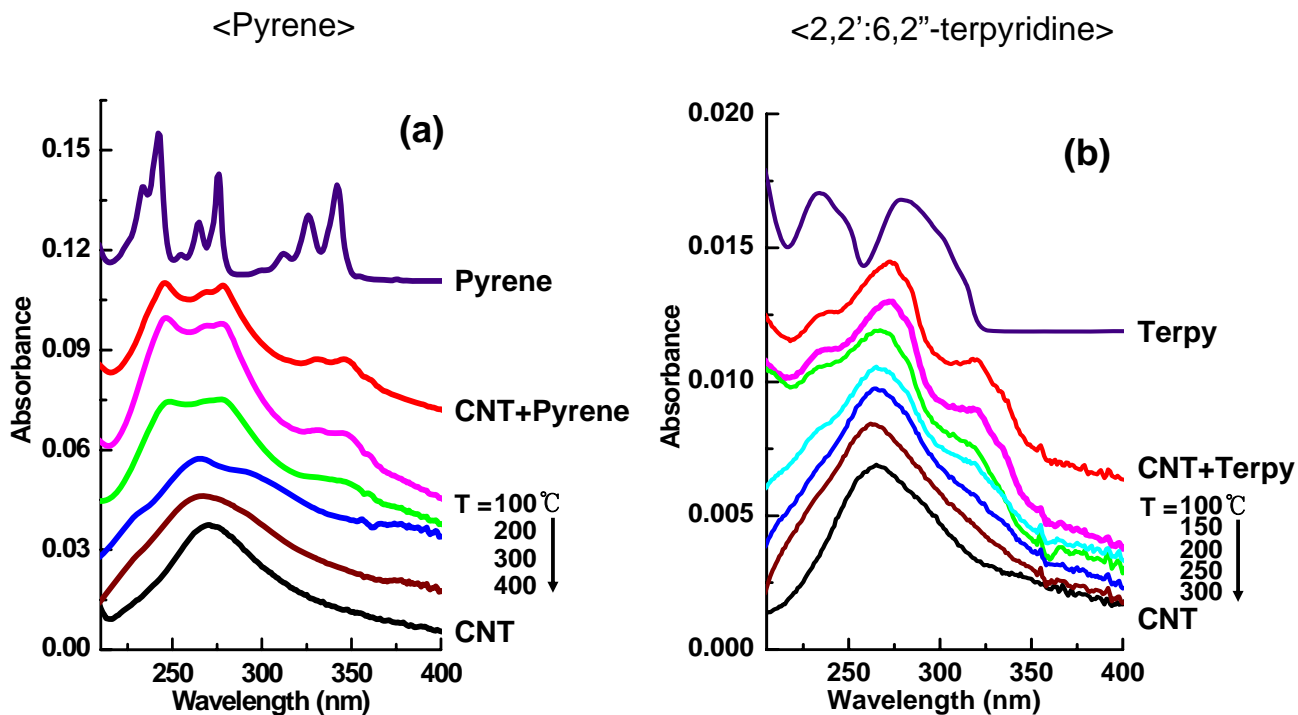
## Reaction procedures



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## Thermal stability of Pyrene and Terpy functionalized on SWNT

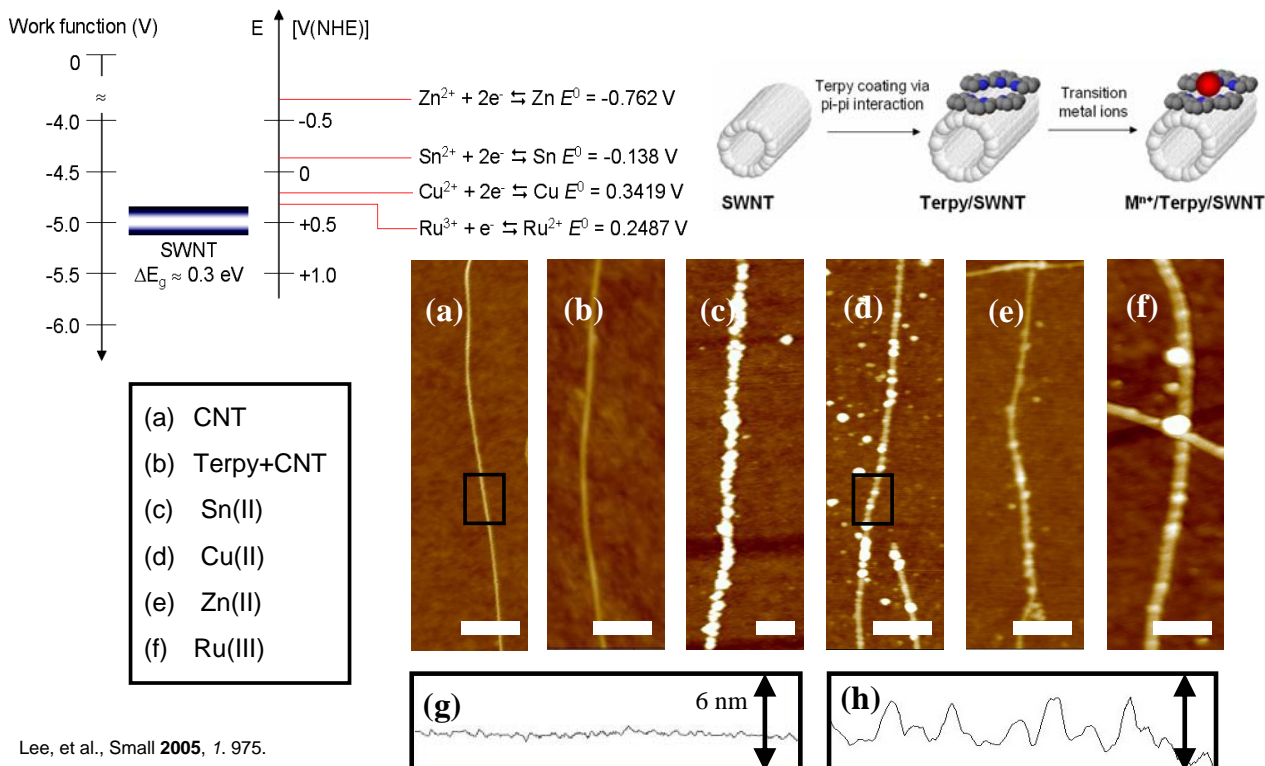


Lee, et al., Small 2005, 1, 975

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## Spontaneous formation of transition metal nanoparticles on SWNT



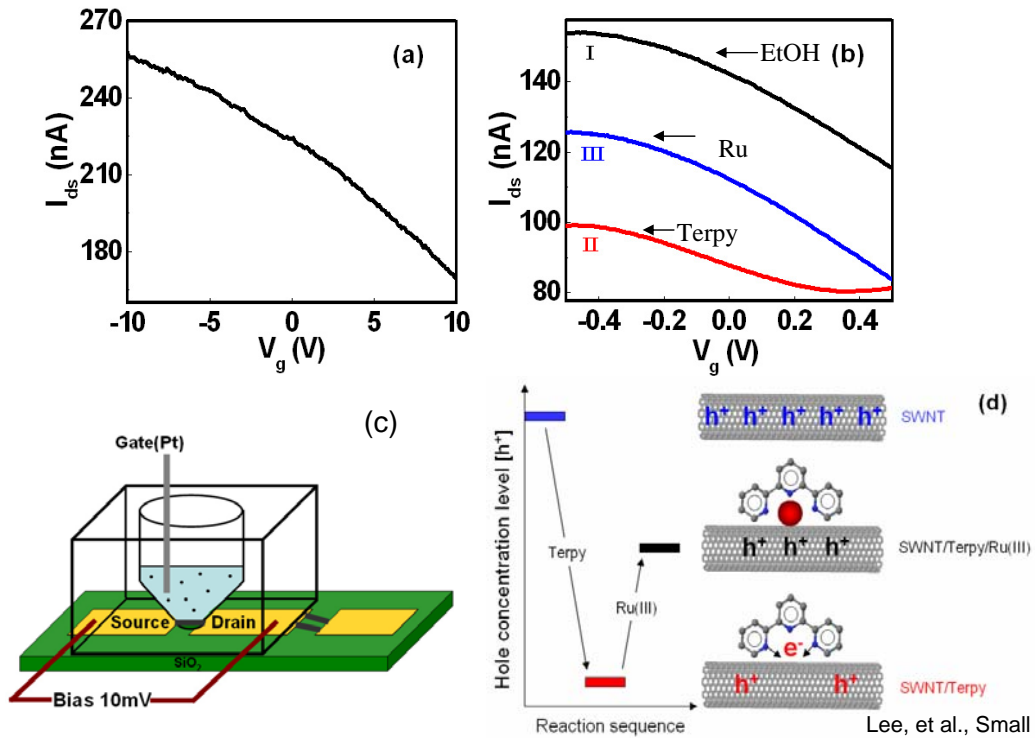
Lee, et al., Small 2005, 1, 975.

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# Charge transfer observation using SWNT-FET devices

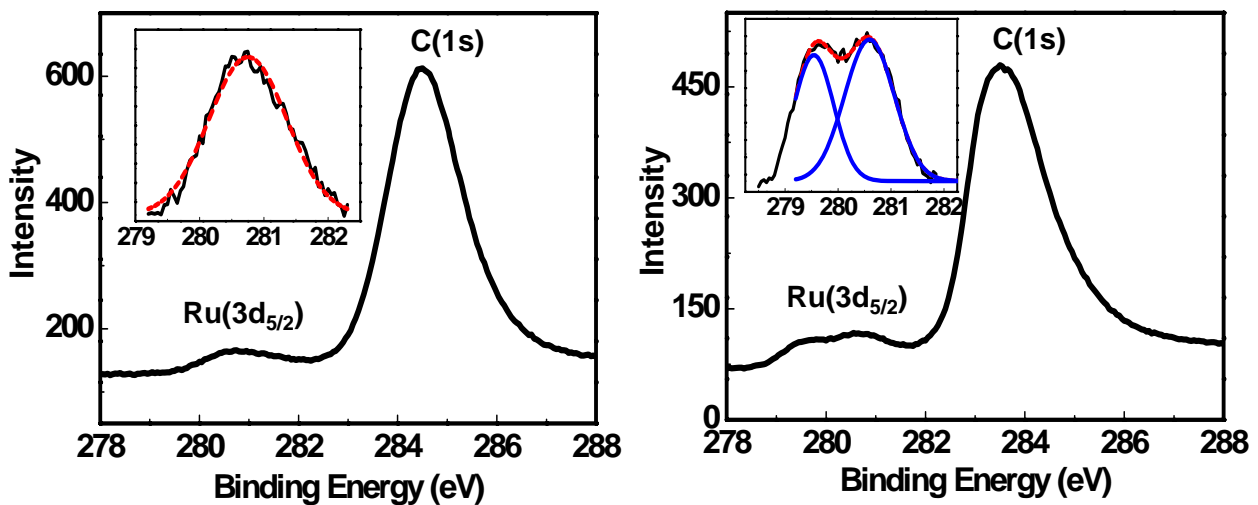
## Current-gate potential ( $I_{ds}$ ) characteristics of network SWNT-FET devices



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## X-ray photoelectron spectroscopy of RuCl<sub>3</sub> particles



Ru on SiO<sub>2</sub>/Si



Ru(III)

Lee, et al., Small 2005, 1, 975

Ru on Terpy coated SWNT on SiO<sub>2</sub>/Si



Ru(0), Ru(III)

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## Summary

Single walled carbon naotubes etch  $\text{SiO}_2$  resulting in sub-10 nm scale nanotrenches

Single walled carbon naotubes role successfully as an efficient nanoscale platform

1. Noble or transition metal nanoparticle-SWNT junction system

