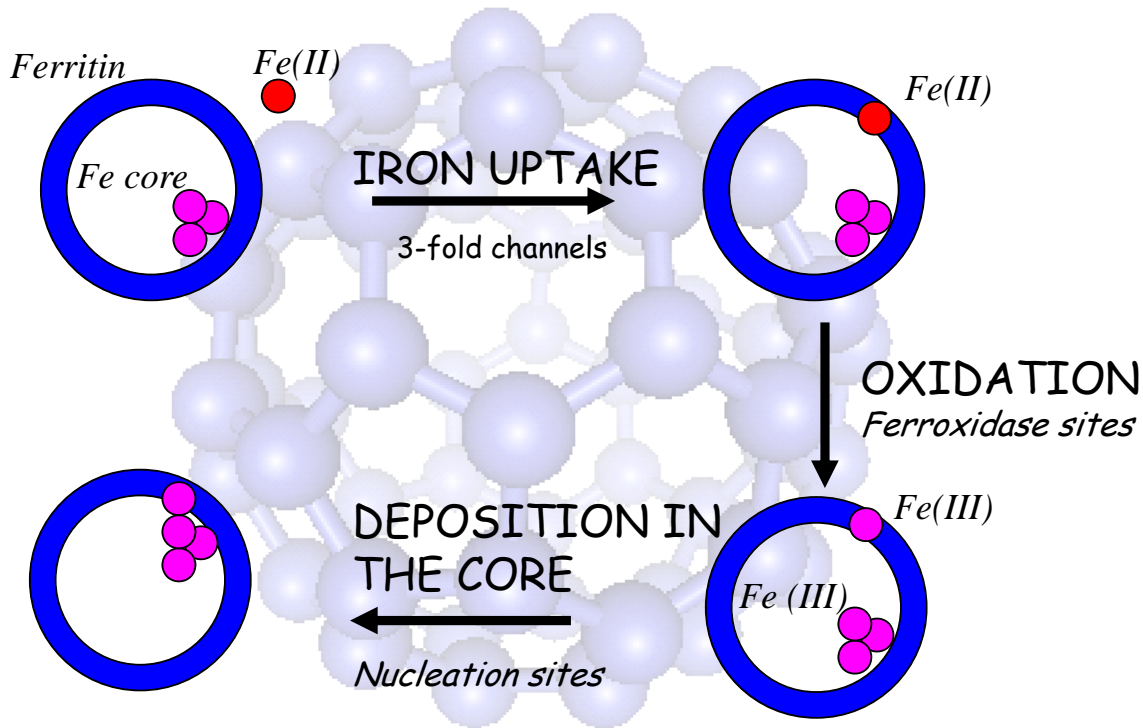
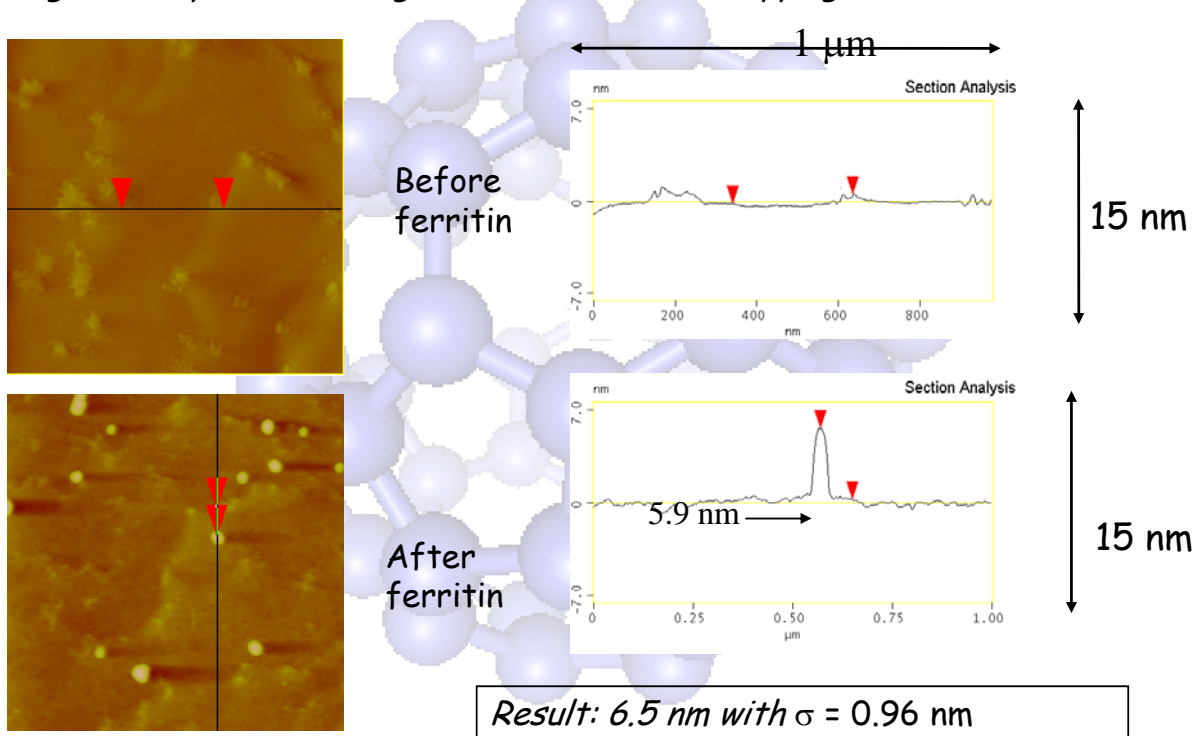


Iron uptake steps

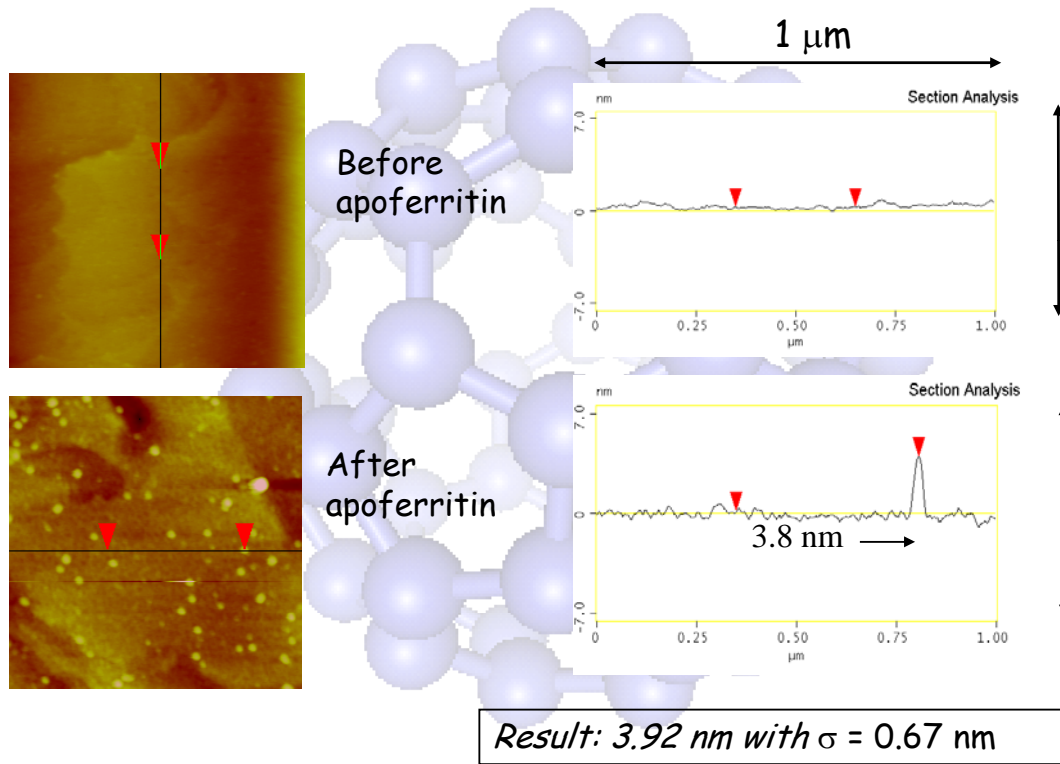


TM AFM on ferritin

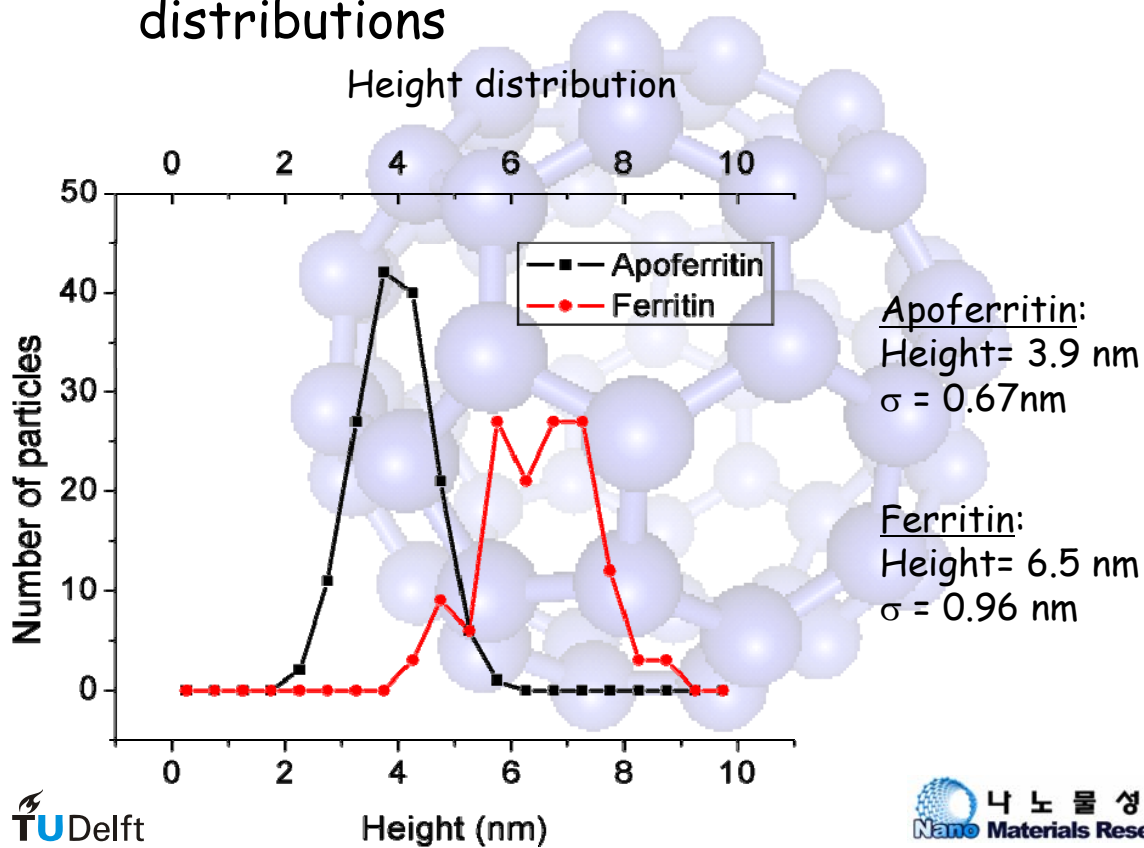
Height of dry **ferritin** on gold substrates with Tapping Mode AFM.



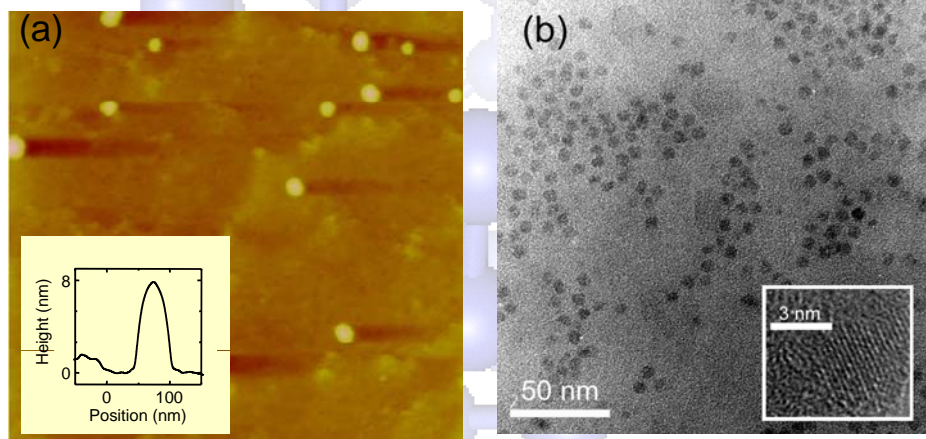
TM AFM on ferritin



Apoferritin and ferritin height distributions



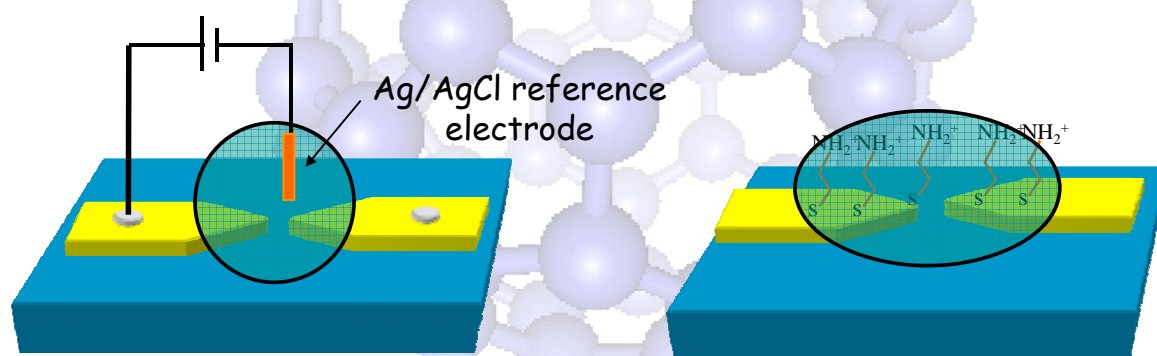
Ferritin has uniform size distribution with unique properties



How to make a contact to the single ferritin molecule?

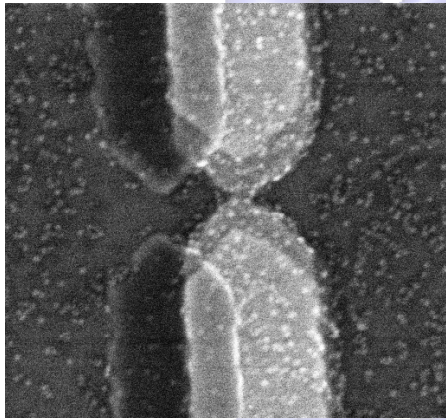
1. Electrostatic trapping

2. Self assembly

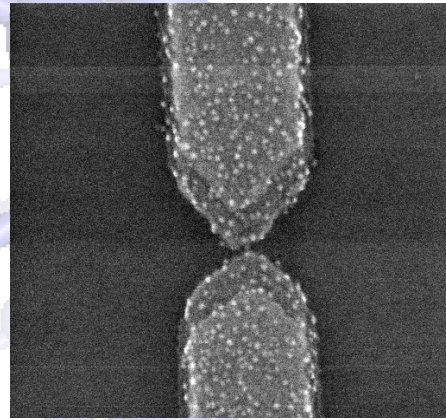


Sample Preparation

Protein concentration dependence



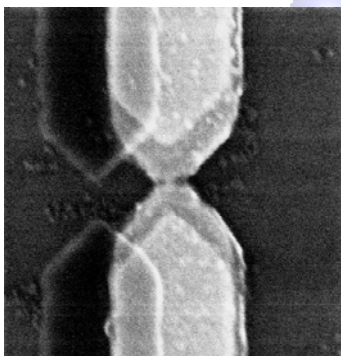
100mM NaCl, pH 7.5,
7.3 μ M ferritin



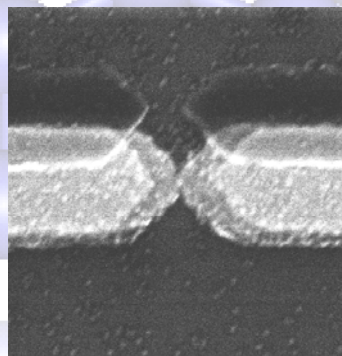
100mM NaCl, pH 7.5,
3.7 μ M ferritin

Sample Preparation

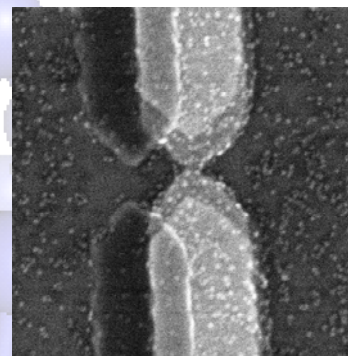
Salt concentration, pH dependence



10mM NaCl, pH 7

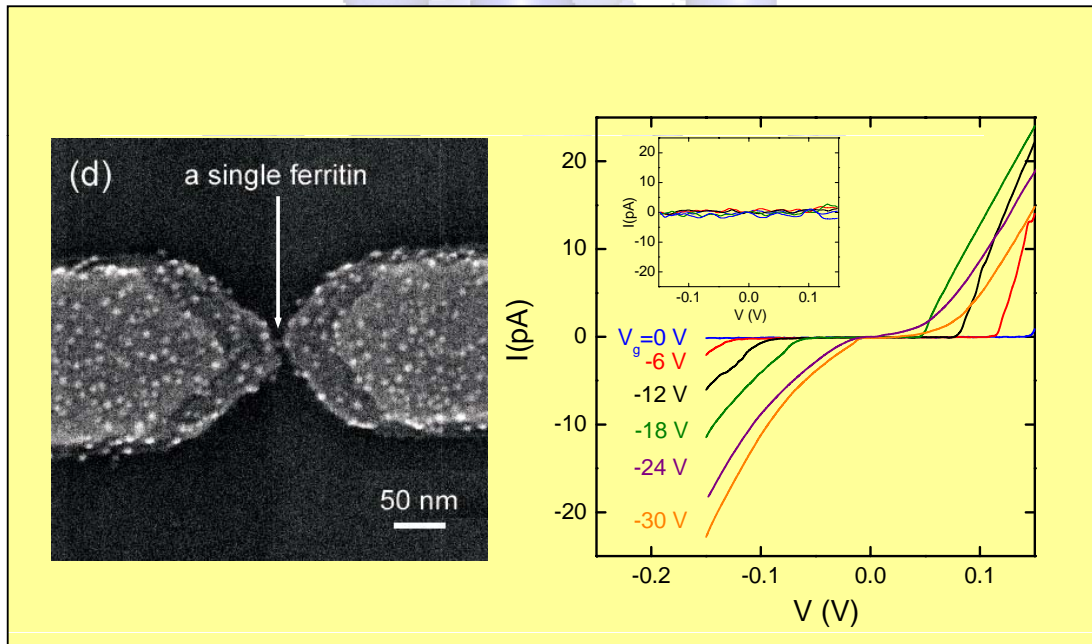


100mM NaCl, pH 7

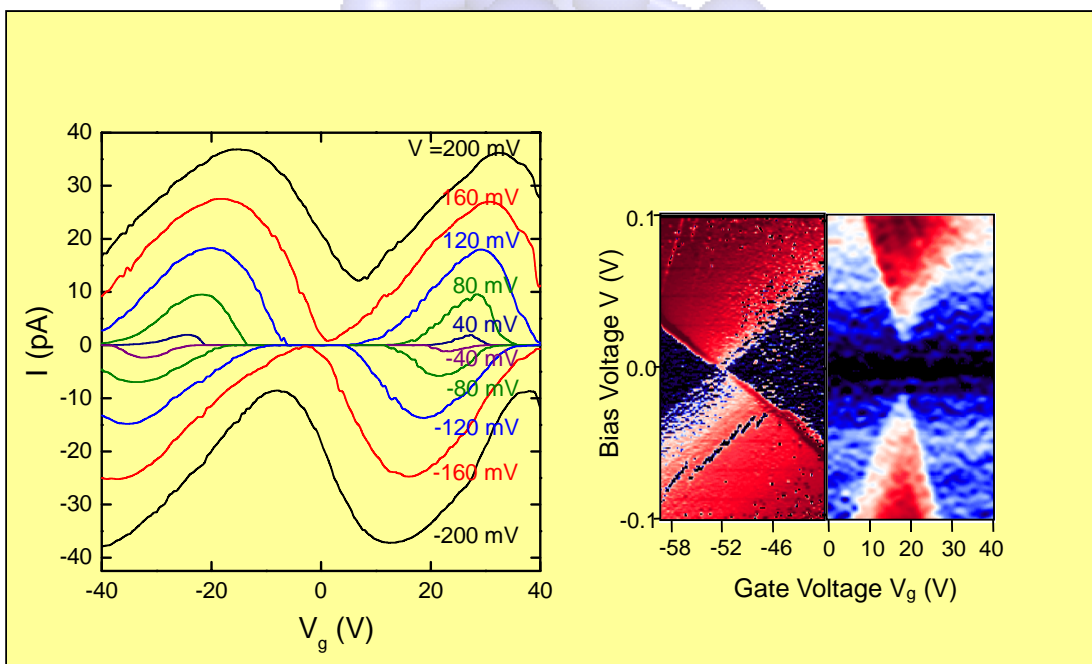


100mM NaCl, pH 7.5

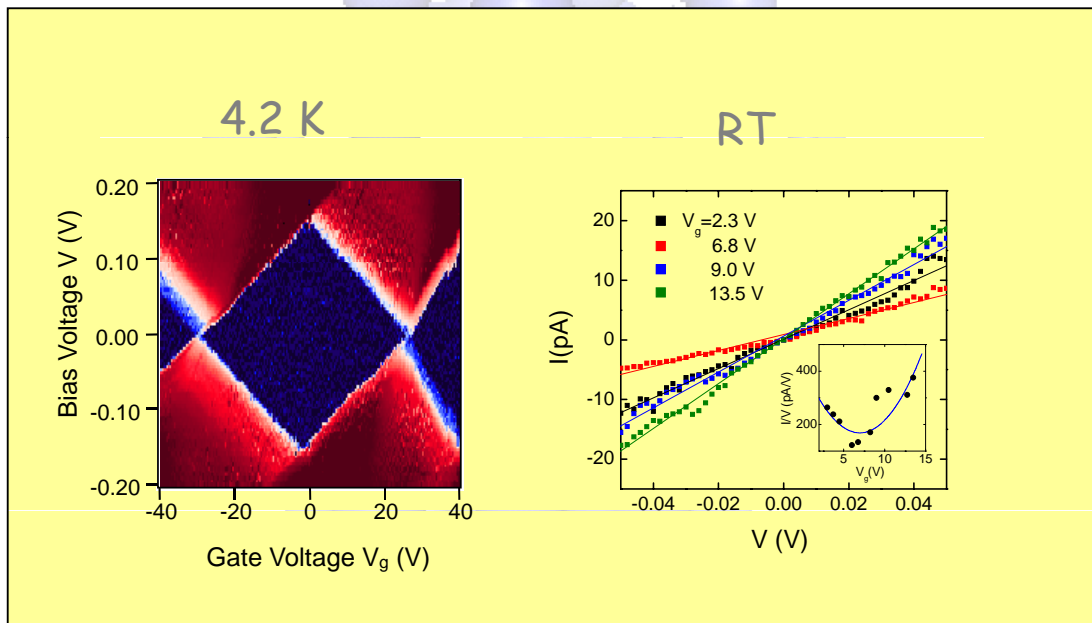
Device fabricated with ferritin



Ferritin single electron transistor



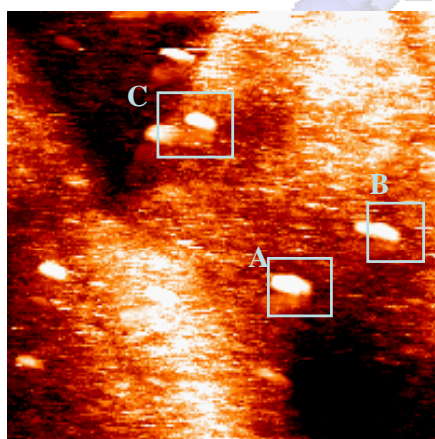
Ferritin single electron transistor-RT SET



STM on ferritin (4.6 K)

Topography

Scan size: 400 nm
V = -2V



➤ Apparent height is bias dependent.

For the same molecule

-1.0 V ~3.0 nm

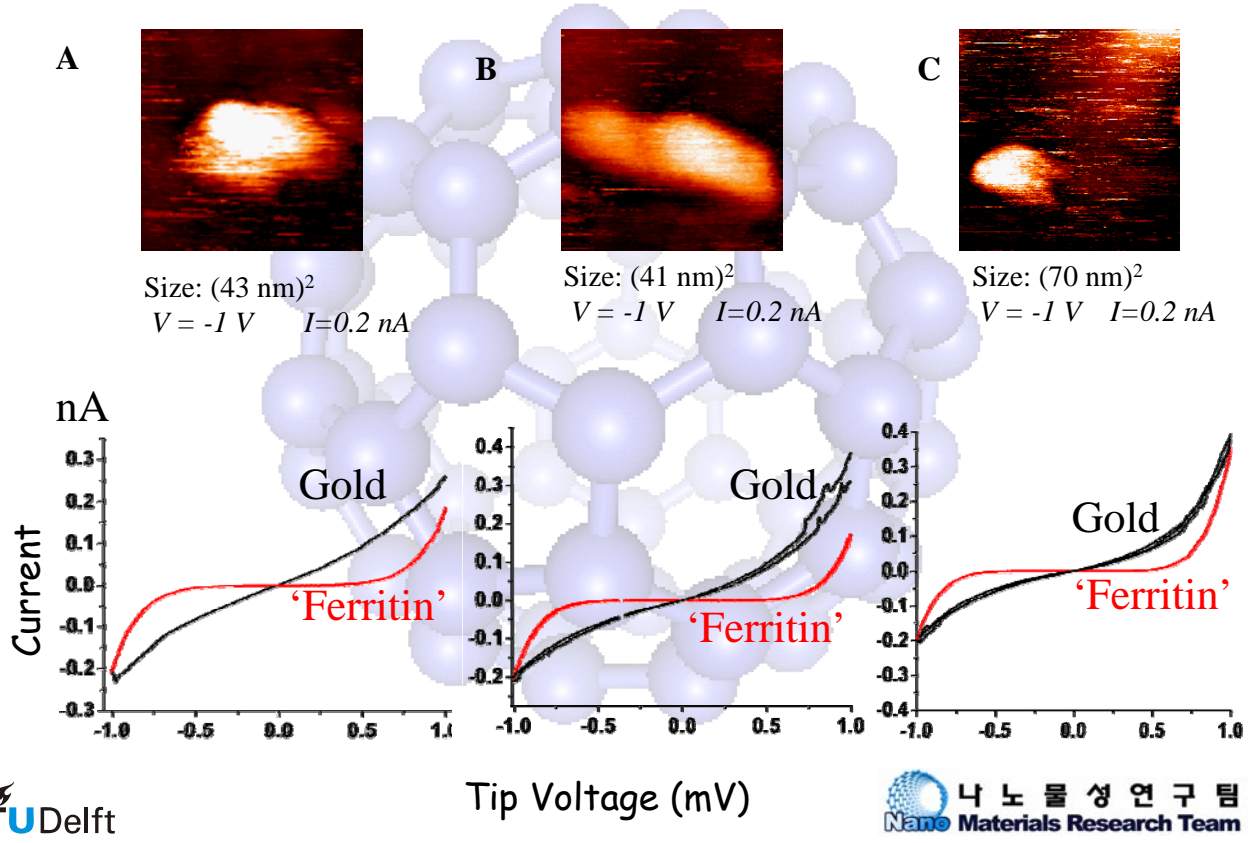
-1.5 V ~3.7 nm

-2.0 V ~4.0 nm

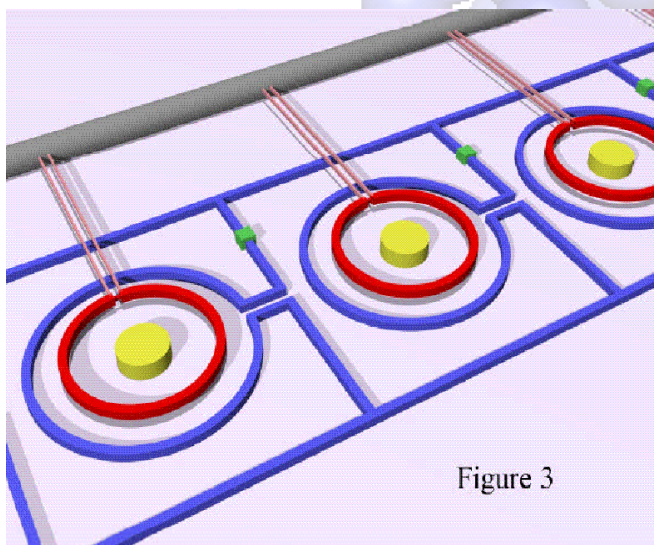
➤ For different samples the height ranged between 2-4 nm.

➤ Tip could be embedded in the protein shell.

Tunneling Spectroscopy (S. Lemay)



A schematic example of coupled controlled qubit



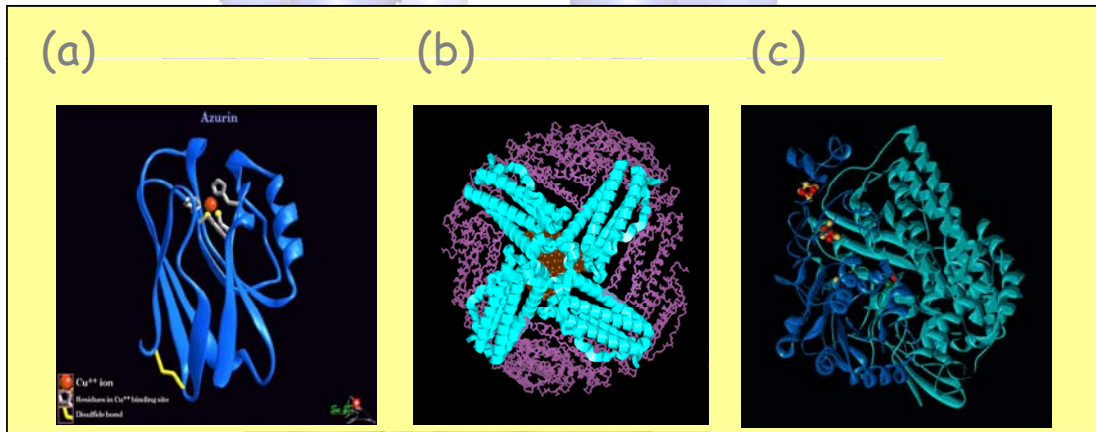
Is it possible to measure the macroscopic quantum tunneling by means of transport measurement?

Figure 3

Tejada *et al.*

Future plans

Other candidates for biomolecular transistor



(a) Azurin

(b) Ferritin (with Ni, Co, Mn, Fe₃O₄ core)

(c) Hydrogenase

Molecular Electronics Team

Cees Dekker

1. Synthesizing Molecules

Richard Egberink
David N. Reinhoudt
University of Twente

Martin Struijk
Réne A. J. Jassen
Eindhoven University
of technology

Andrew Grimsdale
MPIP-Mainz

2. Electrochemical measurement

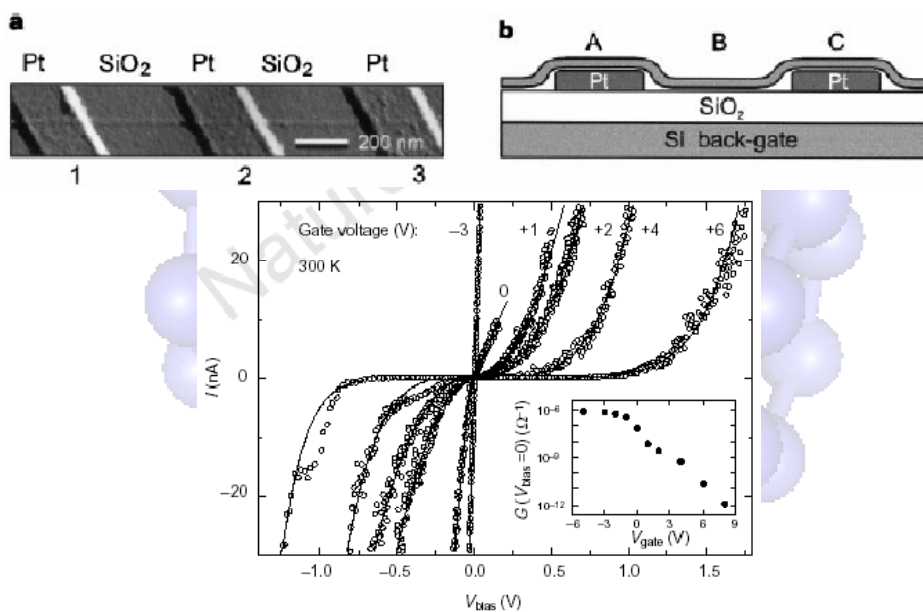
Frank Wiertz
Dirk Heering

3. Transport measurement- Conjugated molecules

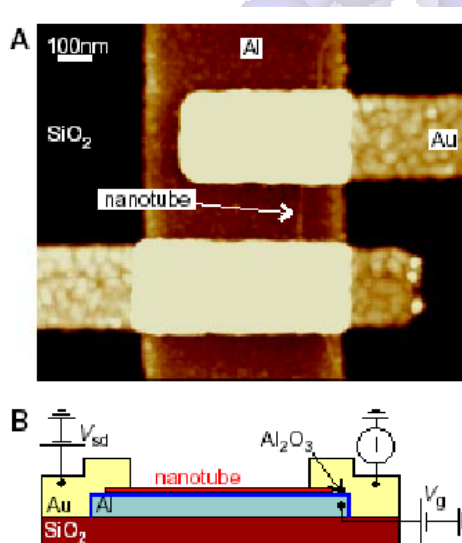
Günther Lientschnig, Peter Hadley

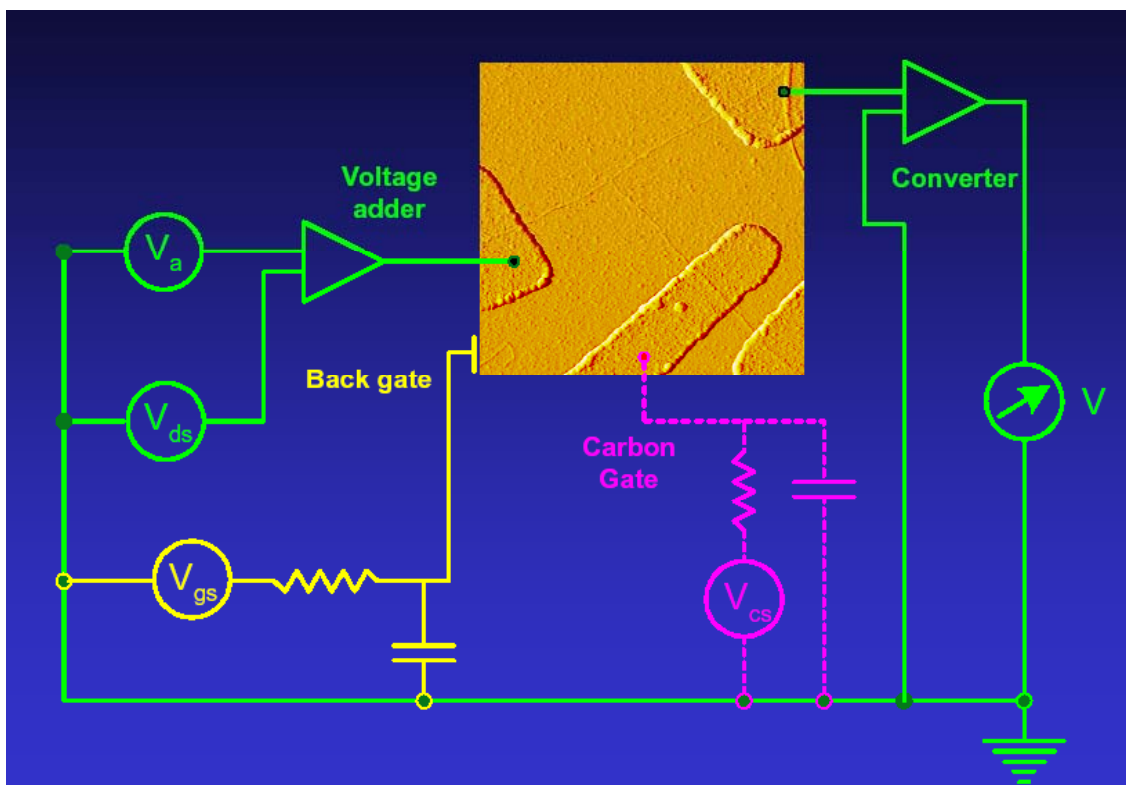
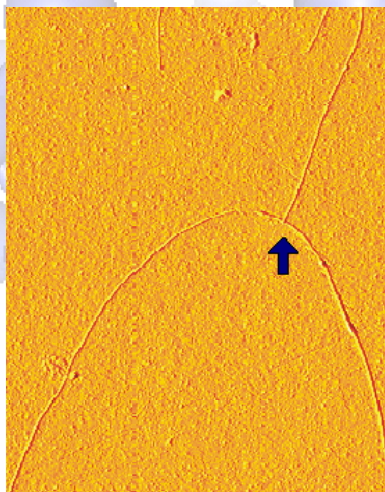
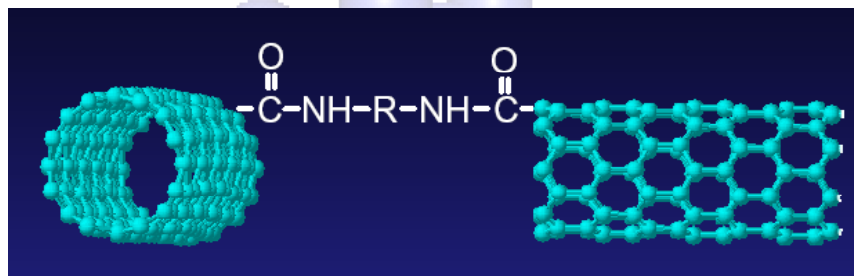
Exotic molecular transistors-evolution of carbon nanotube FET

1st generation

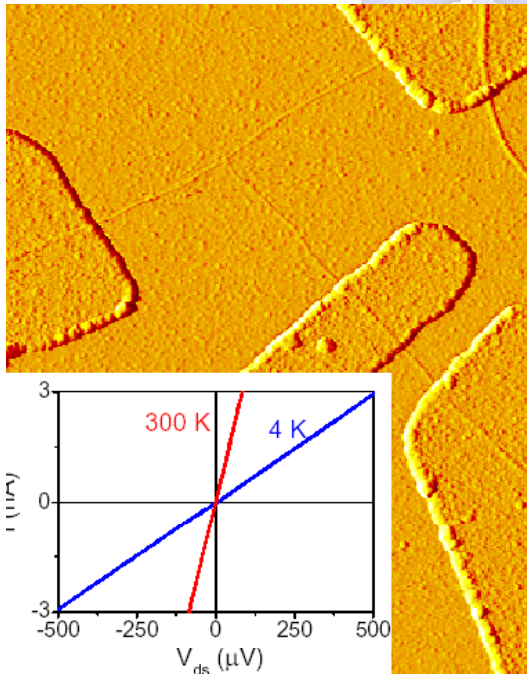


2nd generation

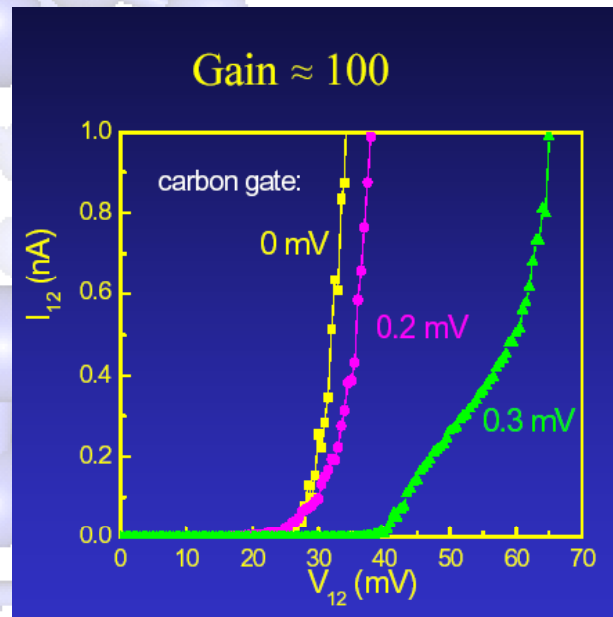
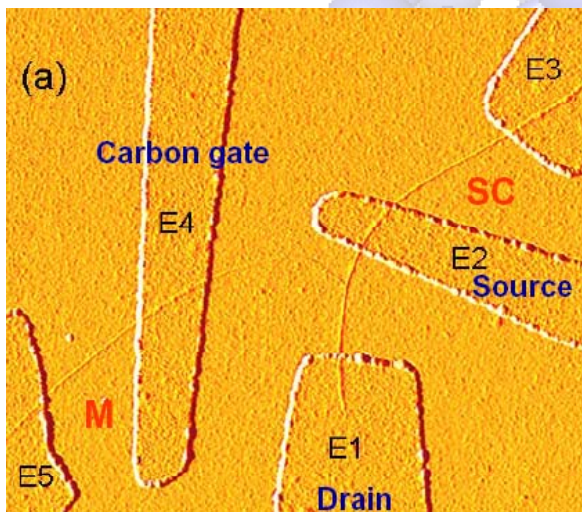
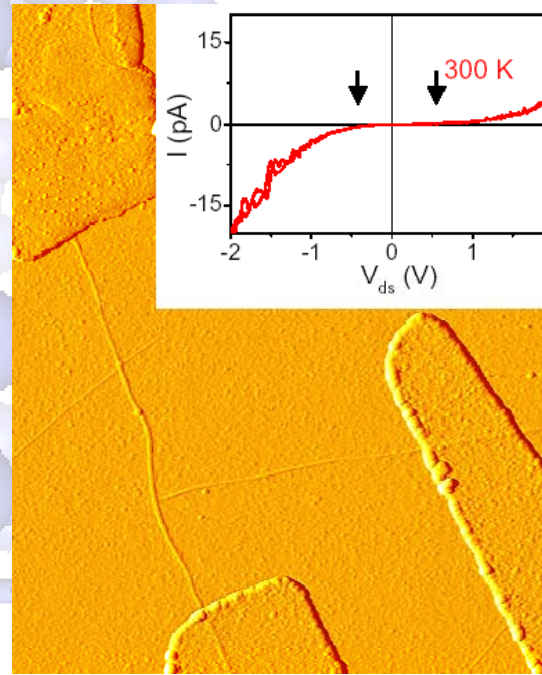




Conductive linker



Non-Conductive linker



References

1. "One dimensional Metals" Sigmar Roth
2. Thanks for online presentation of Mark Reed, Zhenan Bao, Alberto Morpurgo, Nikolai Zhitenev, Kinneret Keren, and MPIP Dresden.

