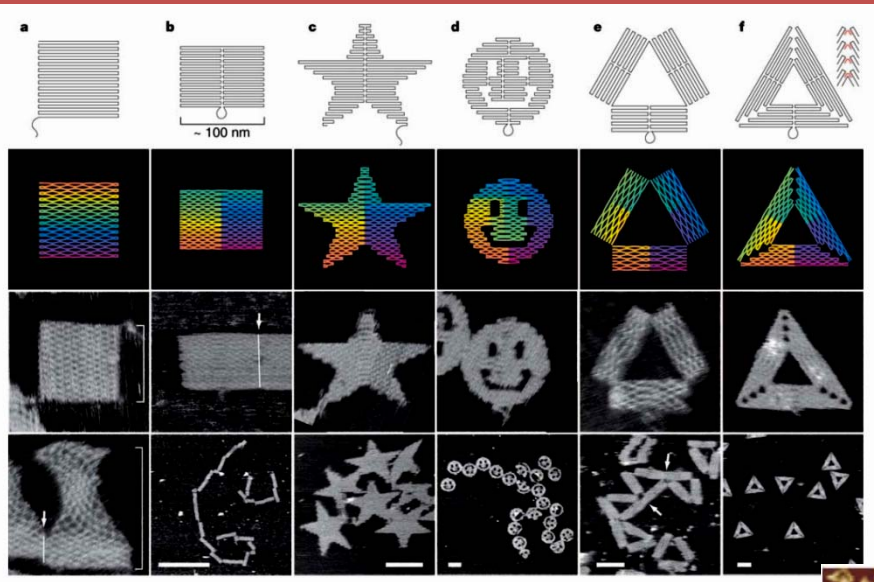
The International Workshop
on DNA-based nanotechnology:
Construction, mechanics, and electronics

National Centre for
NanoScience & Technology

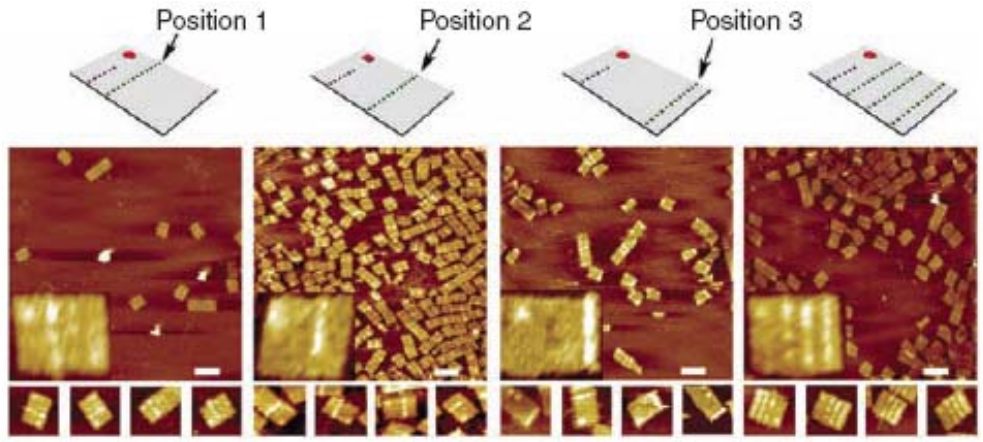
DNA Nanodevices based on i-motif structures

Dongsheng Liu Professor

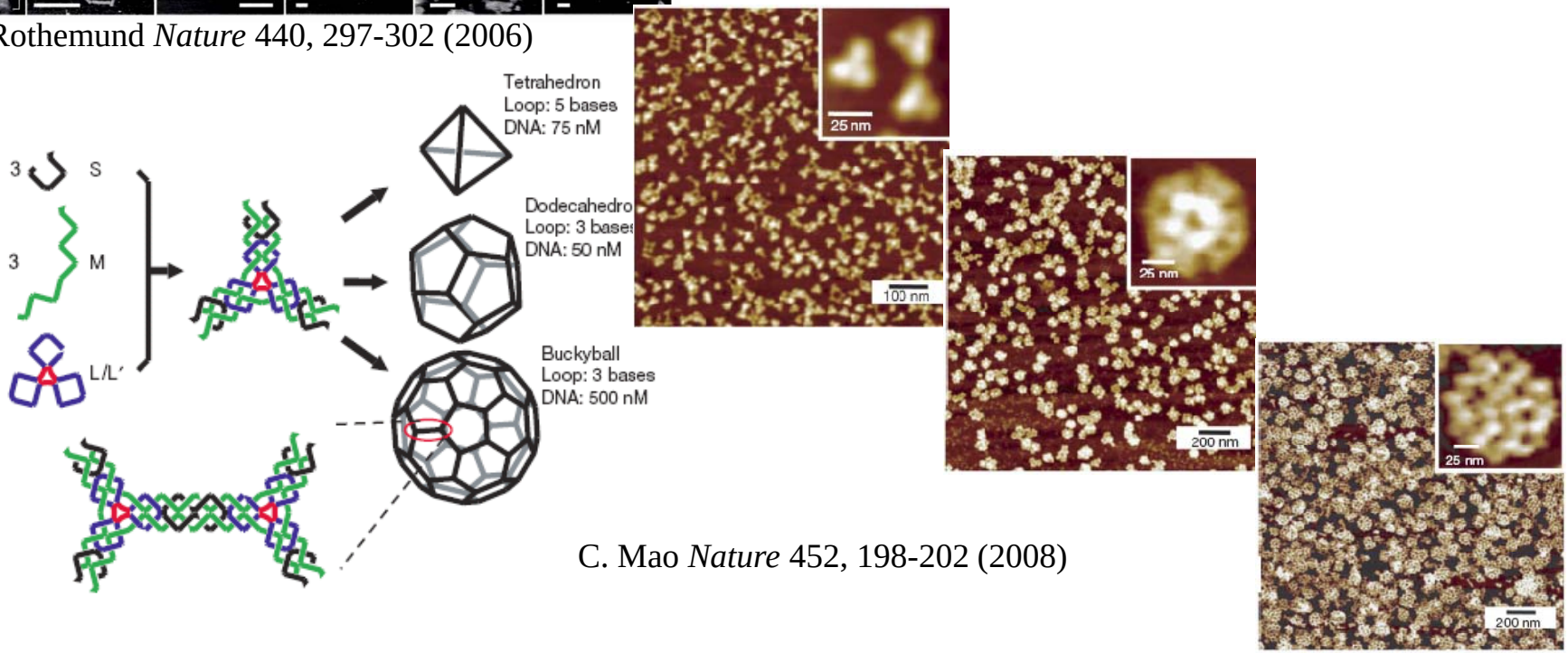
DNA in a material world



P. Rothemund *Nature* 440, 297-302 (2006)

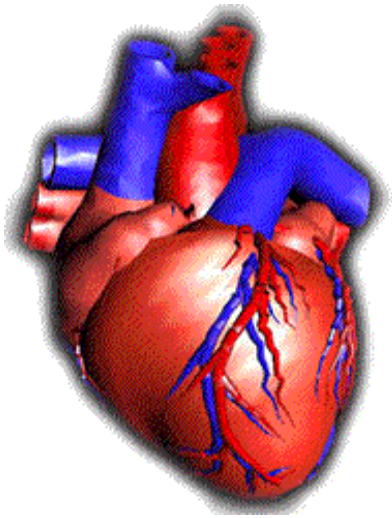


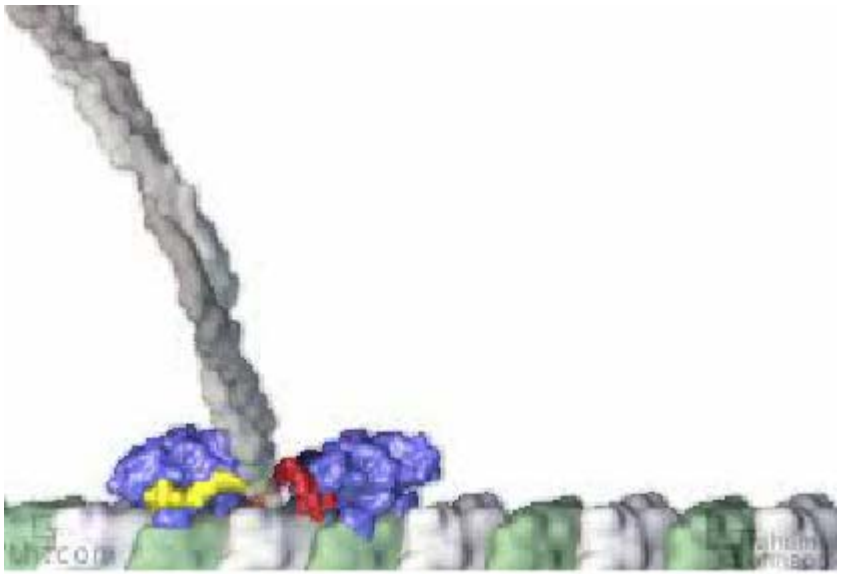
H. Yan et al. *Science* 319, 180-183 (2008)



C. Mao *Nature* 452, 198-202 (2008)

Life is full of machine

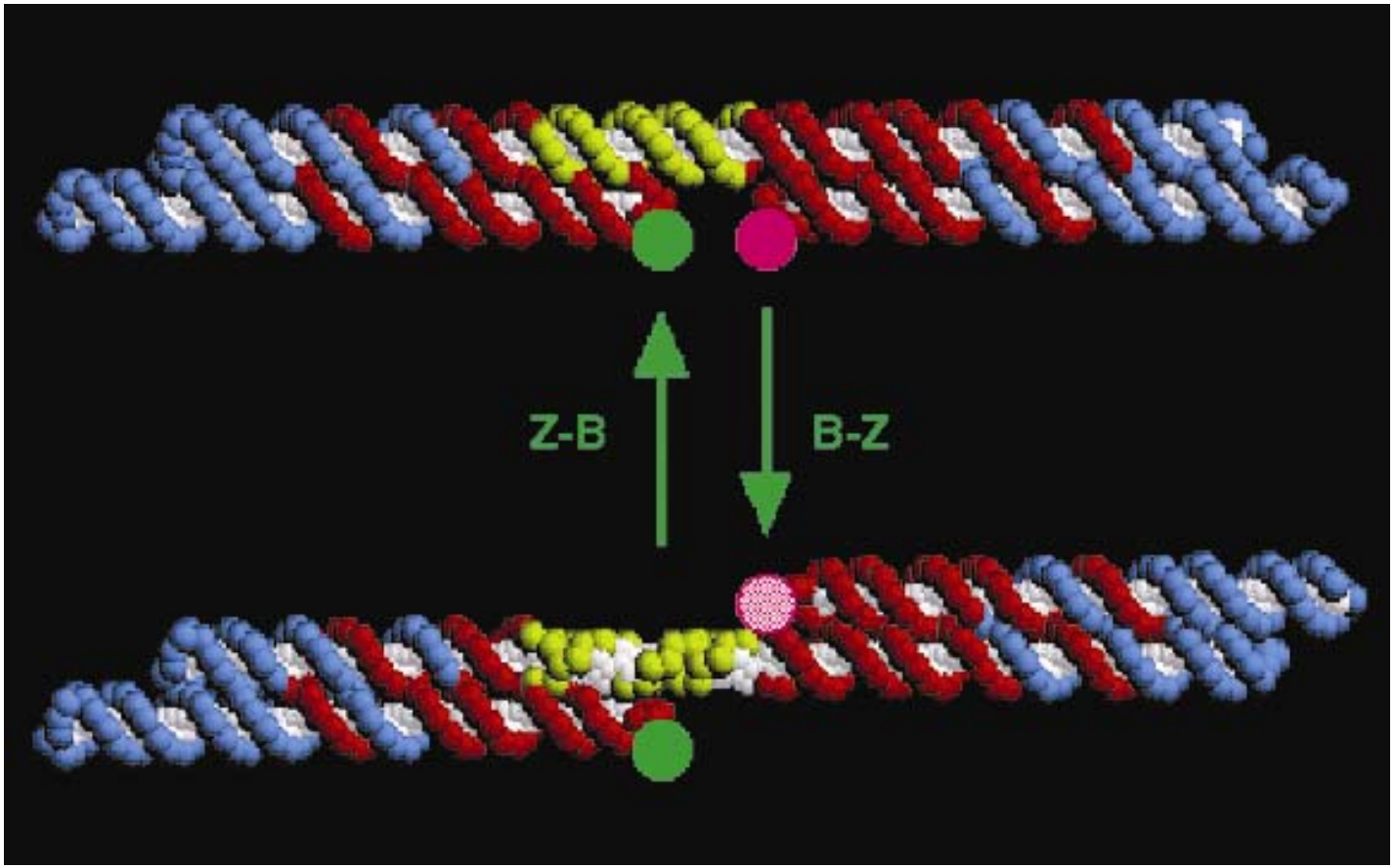




Challenges in DNA nanotechnology

- Can we make DNA machine?
- Can it do work ?
  - Driven method
  - Speed
  - Force output?
  - Reliability
- What will it be used for?

An ion-triggerred DNA rotary machine

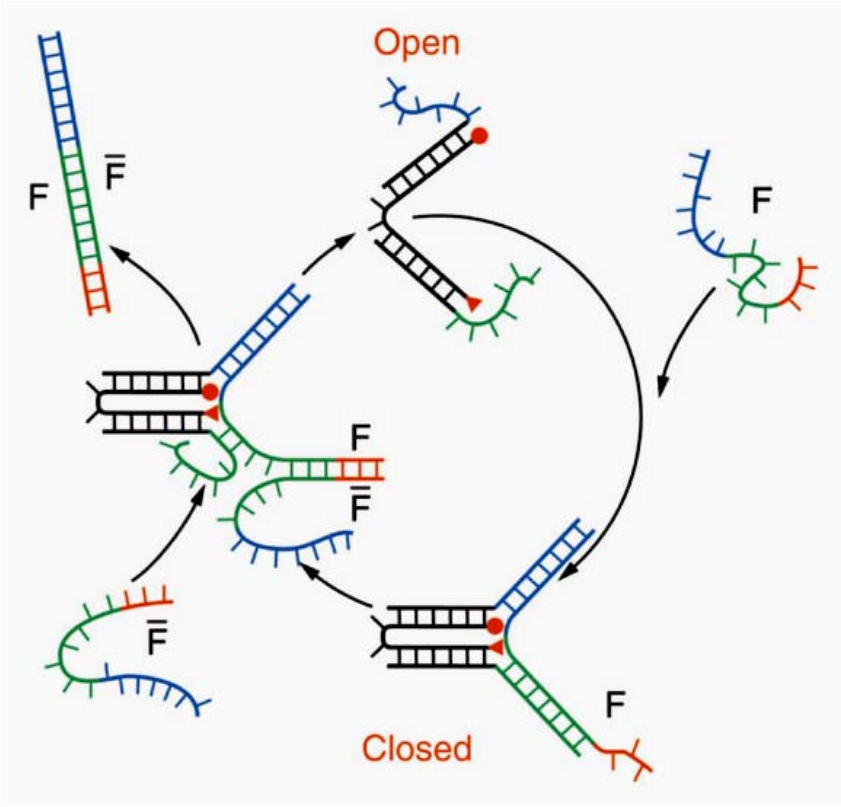


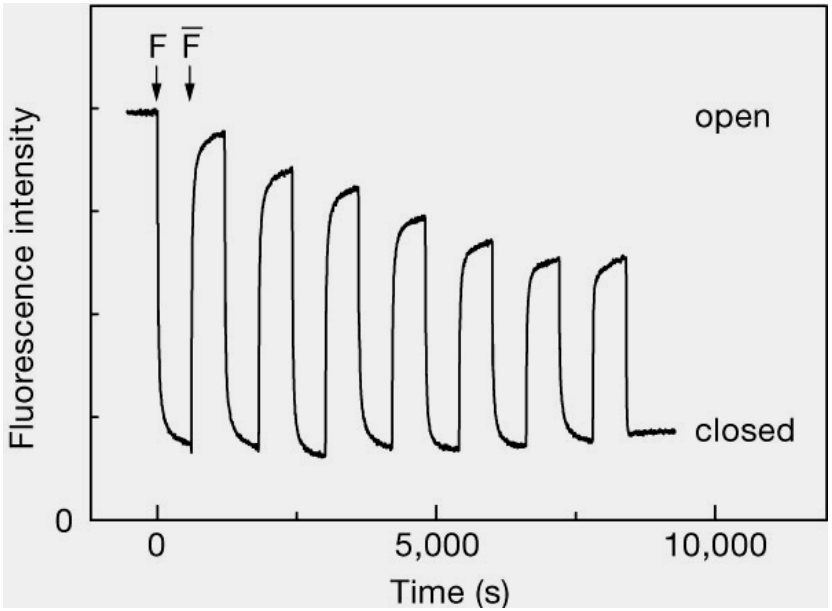
Driven by $Co(NH_3)_6^{3+}$

C. D. Mao, W. Q. Sun, Z. Y. Shen and N. C. Seeman, Nature, 1999, 397, 144-146

DNA-fuelled Molecular Machine Based on Duplex

B. Yurke, A. Turberfield *et. al. Nature* 406, 605 (2000)

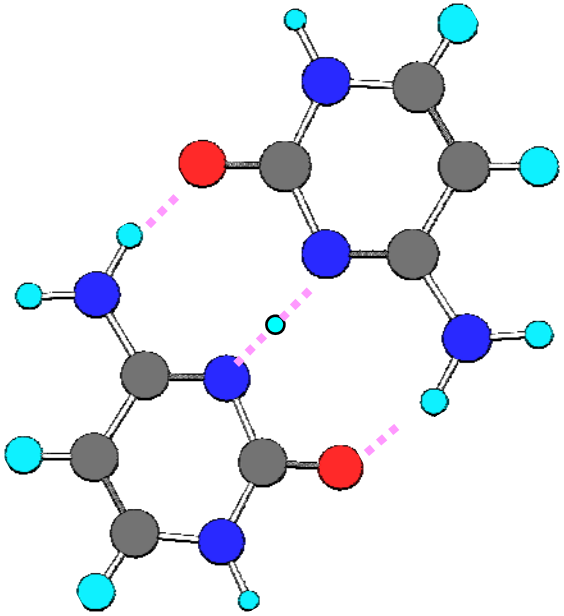




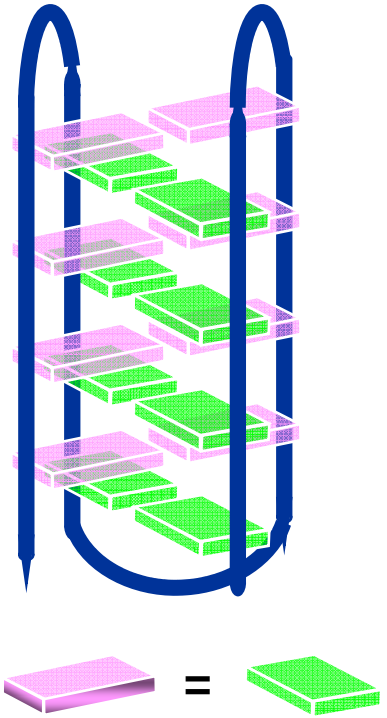
pH sensitive DNA structure

$H^+ + OH^- = H_2O$ is an irreversible, rapid reaction

H_2O and salt are compositions of biological buffers



pH<6.3



pH<6.3

DNA nanomotor driven by proton

D. Liu & S. Balasubramanian, *Angew. Chem., Int. Ed.* **2003**, 42(46), 5734

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X:  5′   CCCTAACCCTAACCCTAACCC   3'
Y:  3′     GATTGTGATTGTGATTG     5'
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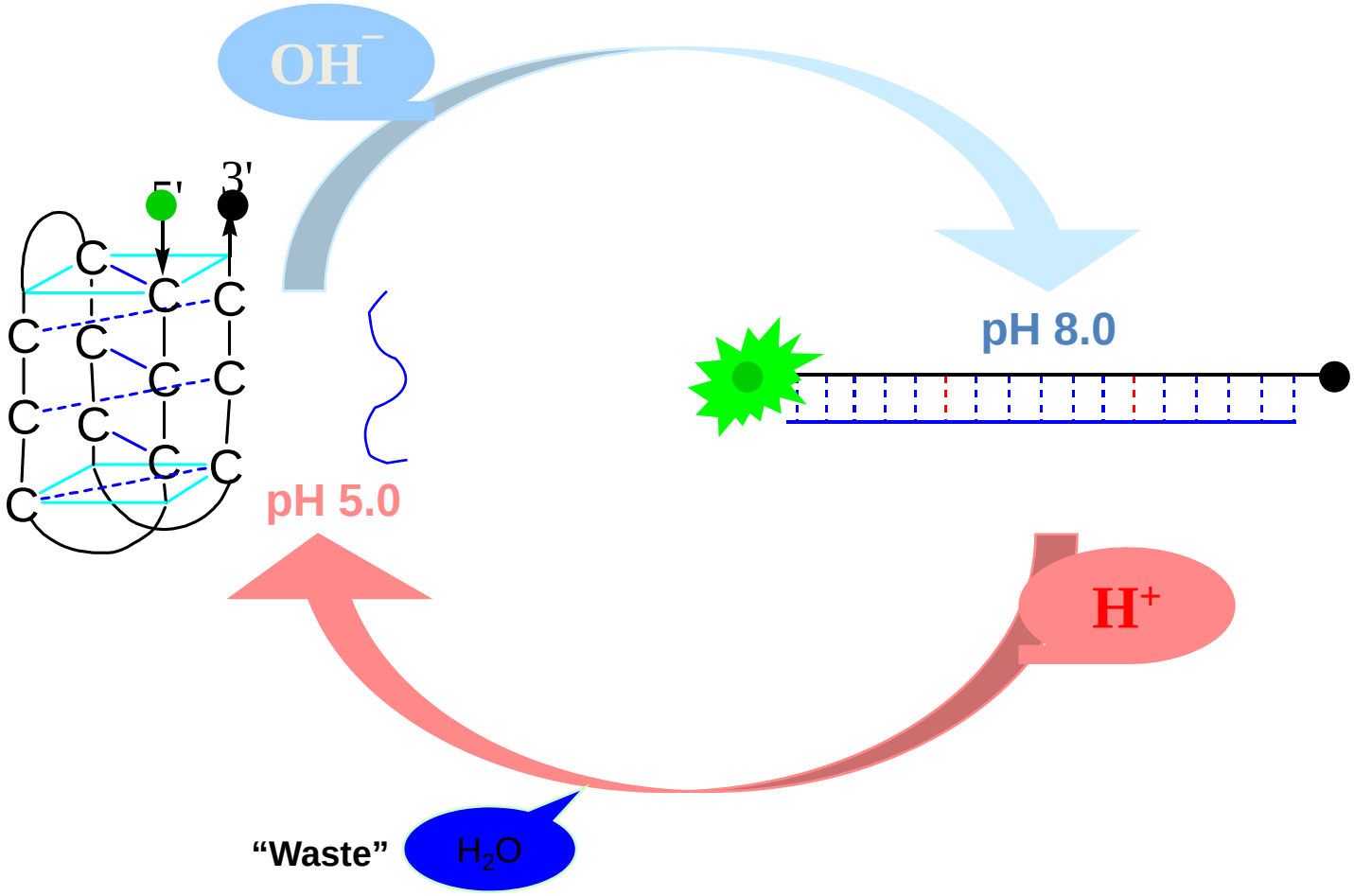
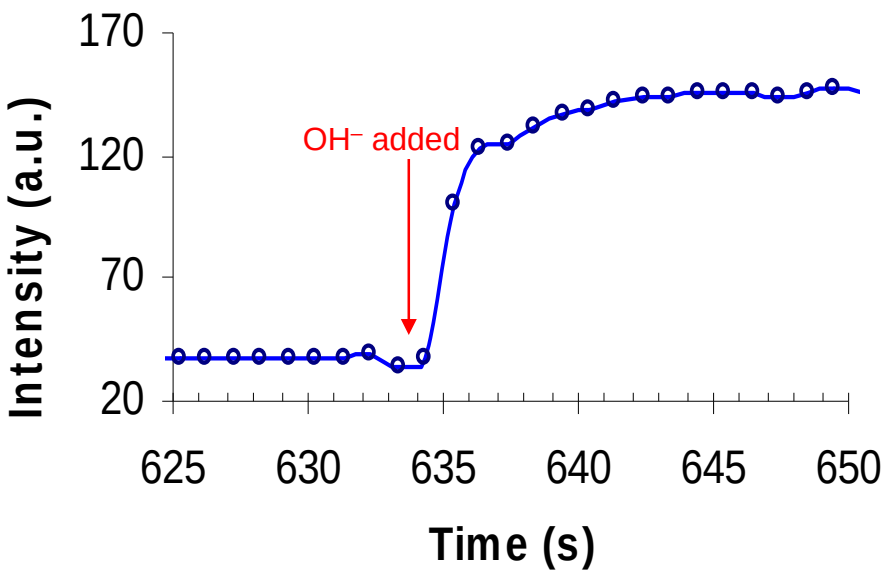
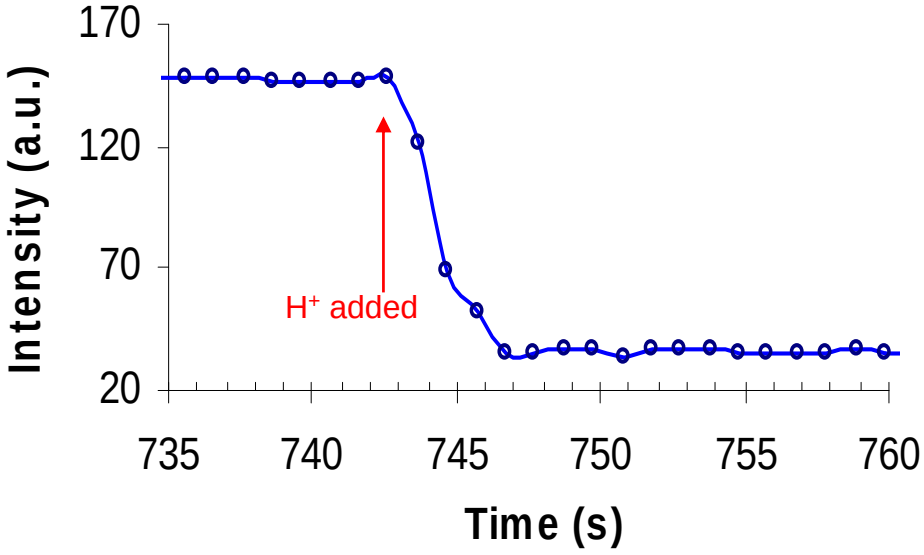


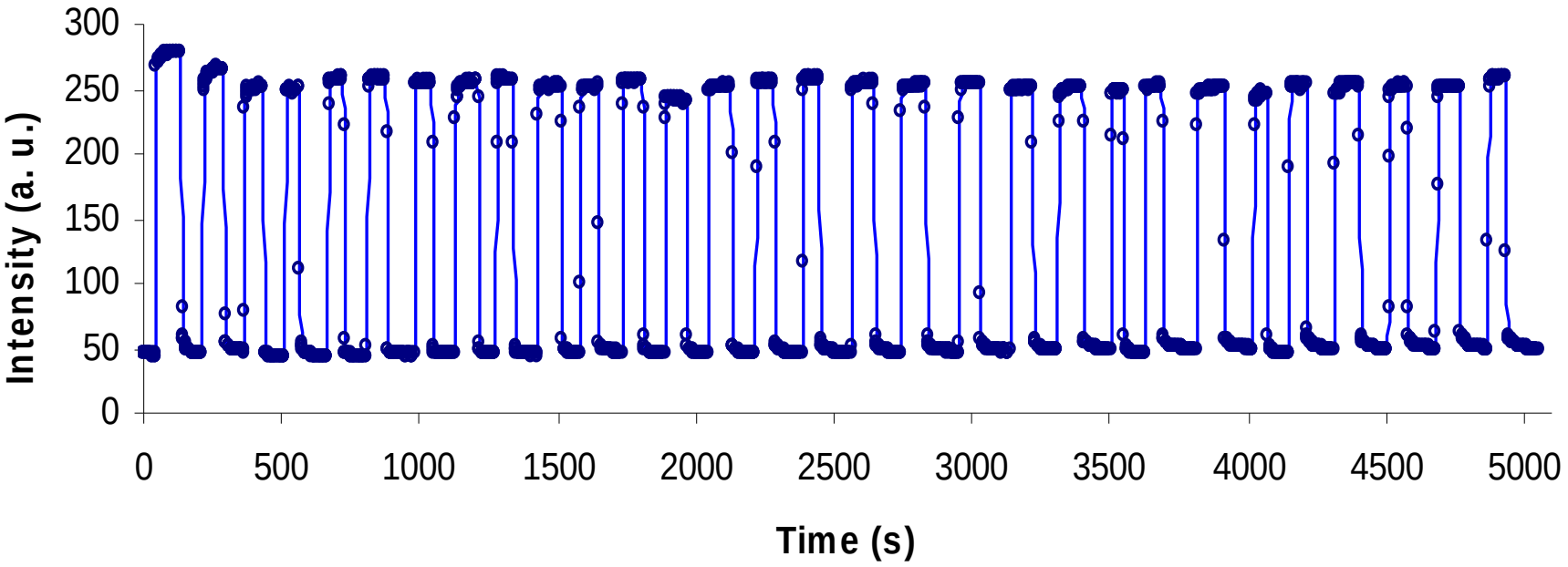
How fast it is?

- Excitation was at 503 nm and emission monitored at 534 nm
- Sampling rate of 0.3 s
- both the opening and closing processes are each completed in ~5 s





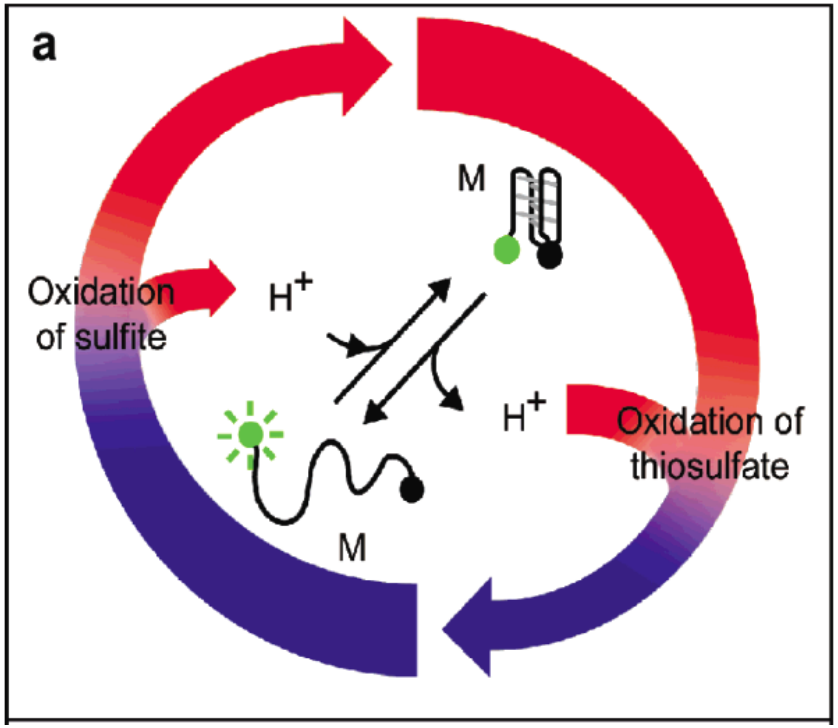
Cycle the machine

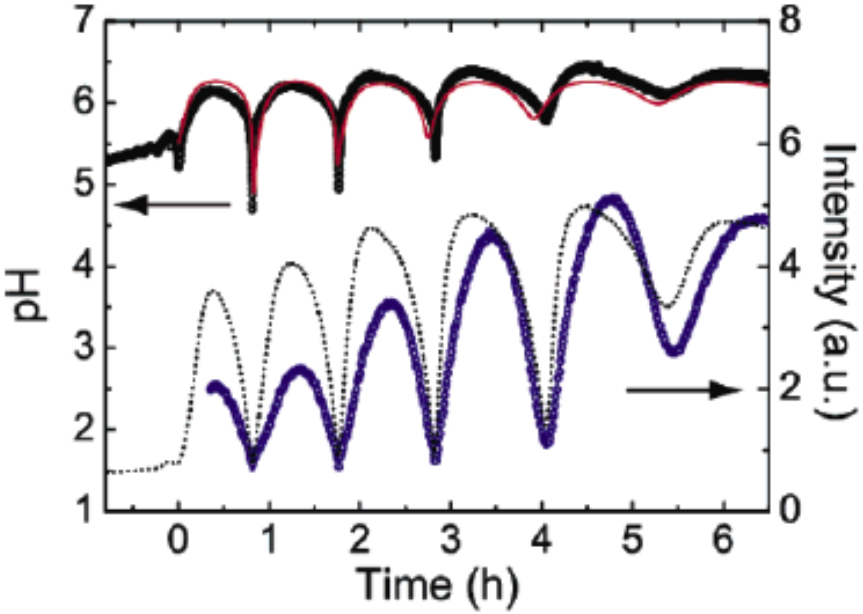


- Over 30 cycles there is negligible reduction in the amplitude of the system (206 $\pm$ 7 a.u. throughout)
- Response is very quick

Switching the Conformation of a DNA Molecule with a Chemical Oscillator

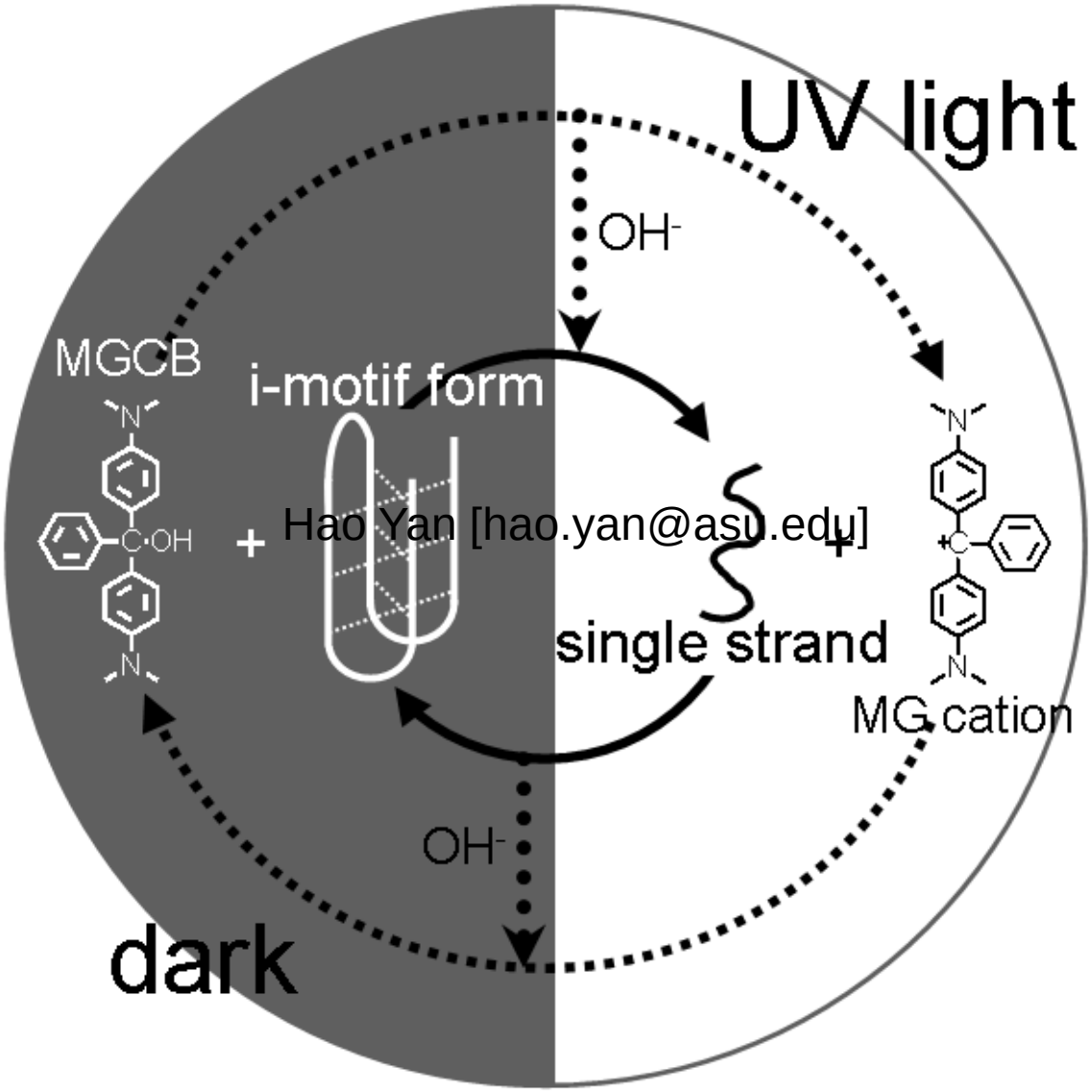
Tim Liedl and Friedrich C. Simmel Nano Lett., Vol. 5, No. 10, **2005**





Light Driven

Angew. Chem., Int. Ed. 2007, 46, 2515-2517



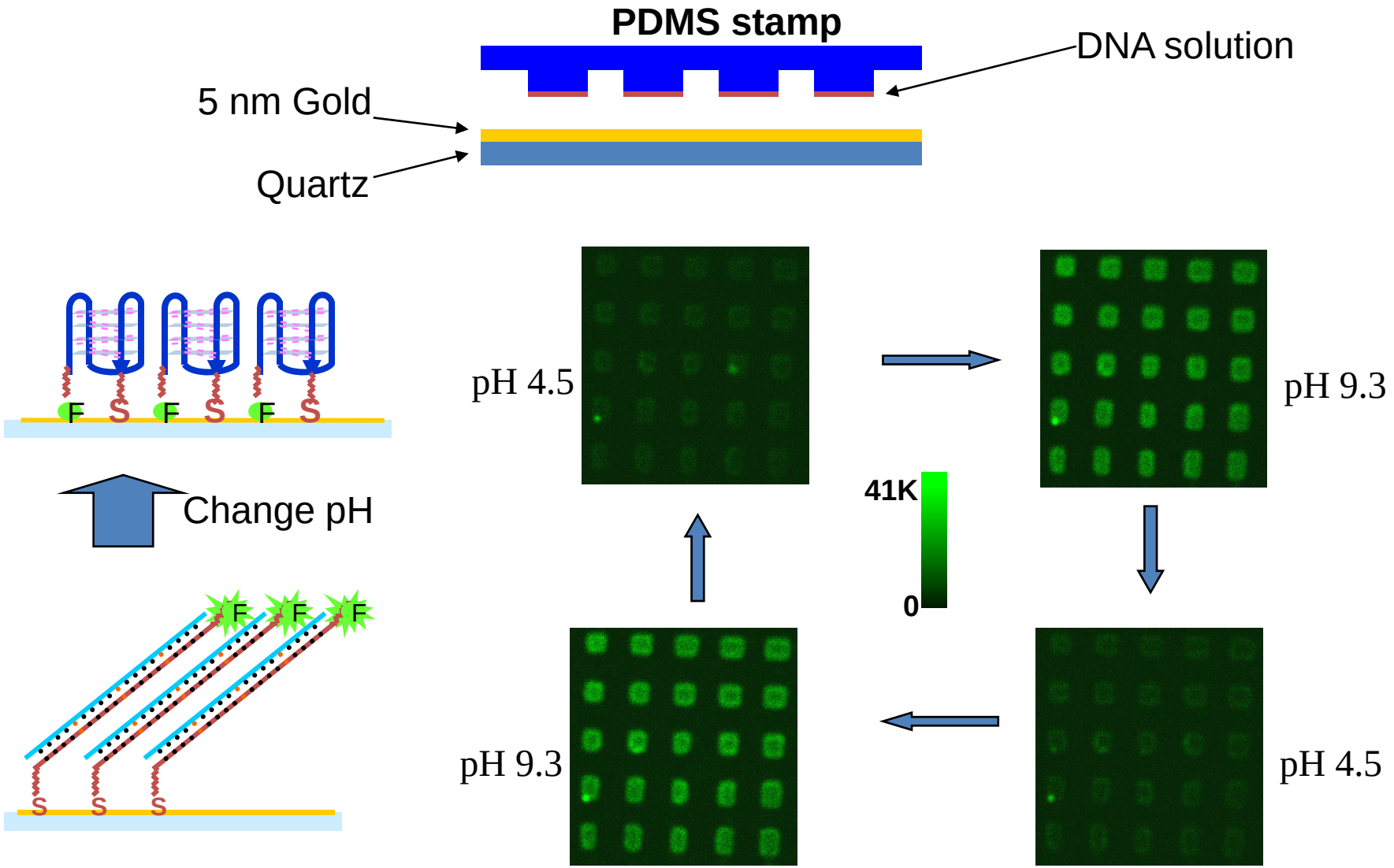
MGCB: malachite green carbinol base

cetyltrimethyl-ammonium bromide (CTAB)

Challenges in DNA nanotechnology

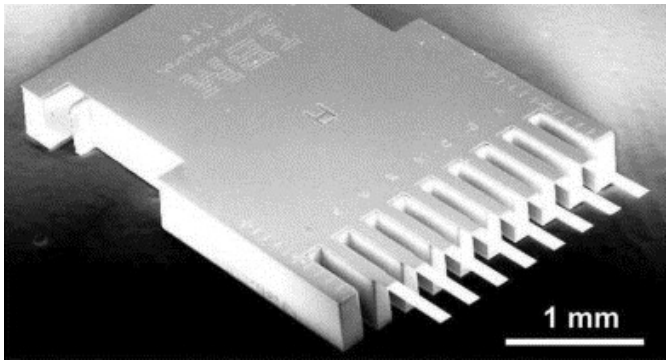
- ✓ Can we make DNA machine!
- ✓ The new driven method has the potential to do work
  - ✓ Speed: 1000 times rapid
  - ✓ Force output: pN
  - ✓ Reliability: Good
- Can it really do work?

Run the motor at Solid/liquid interface *JACS* 2006, 2067-2071

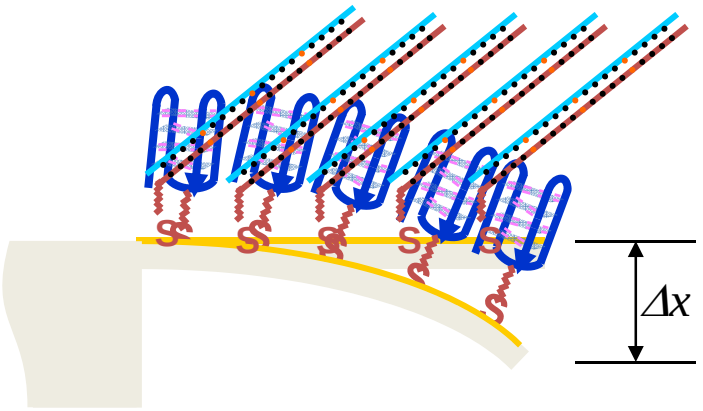


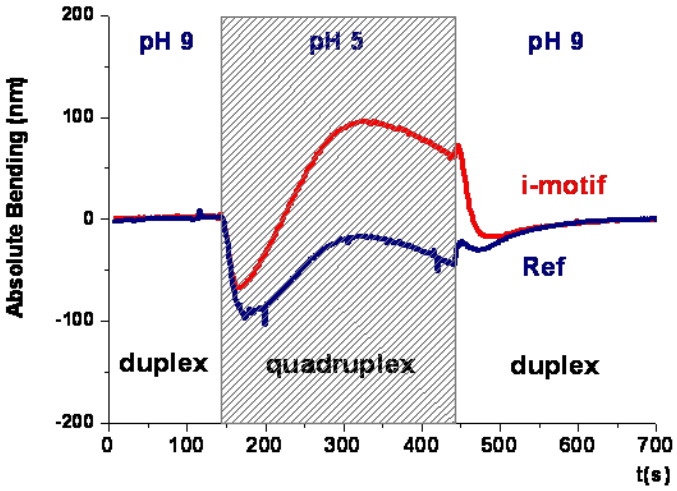
Mechanical movement of microcantilever driven by DNA motor

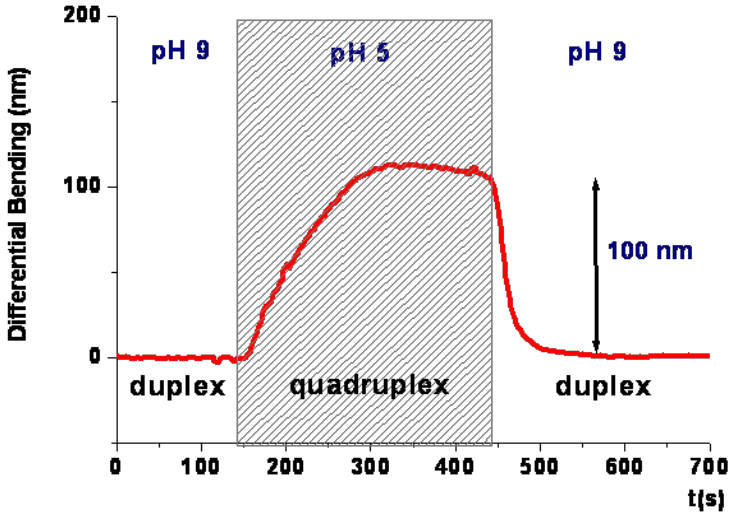
JACS 2005, 127(48): 17054-17060



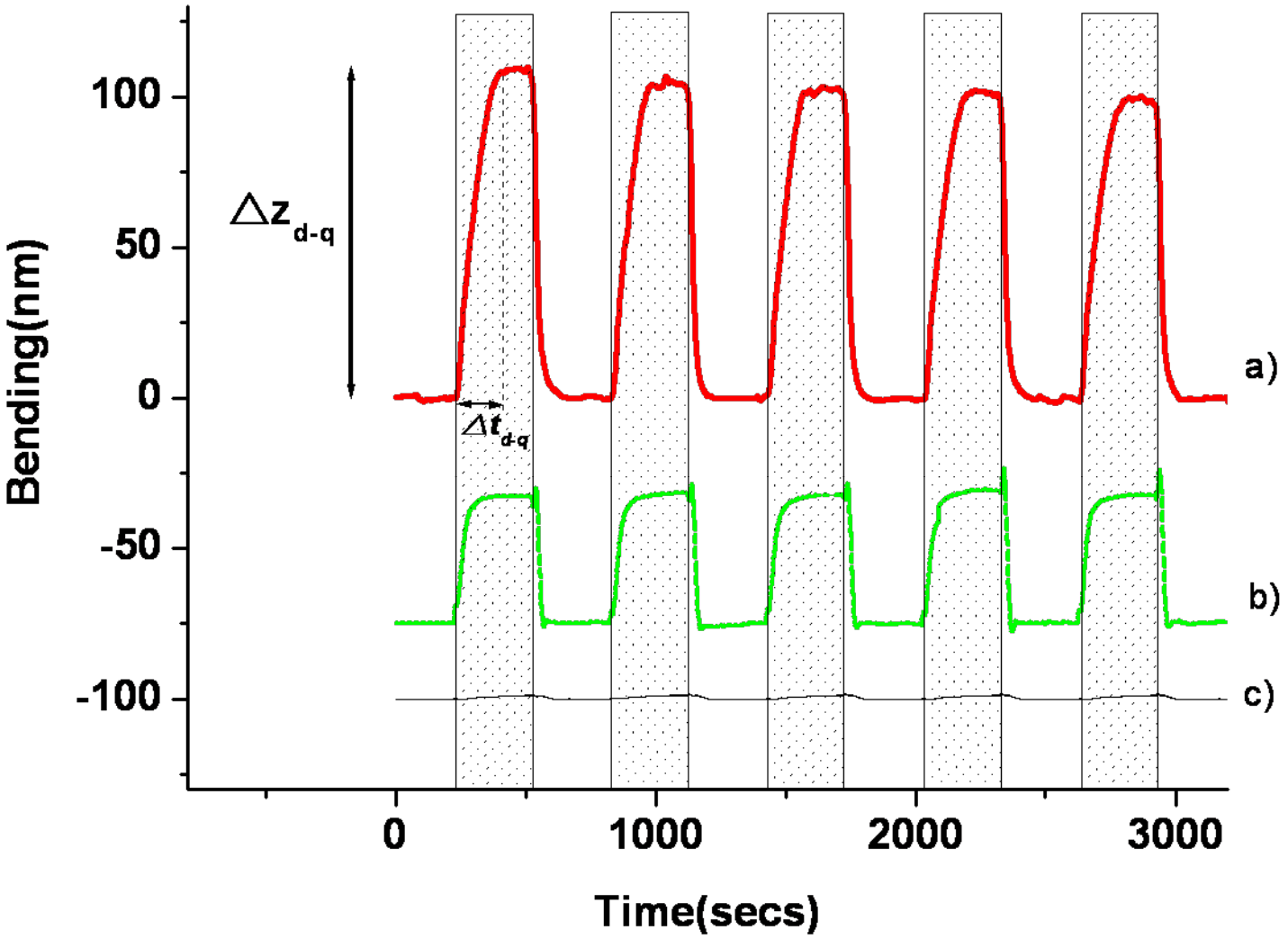
Micro-cantilever array







Mechanical movement of microcantilever driven by DNA motor

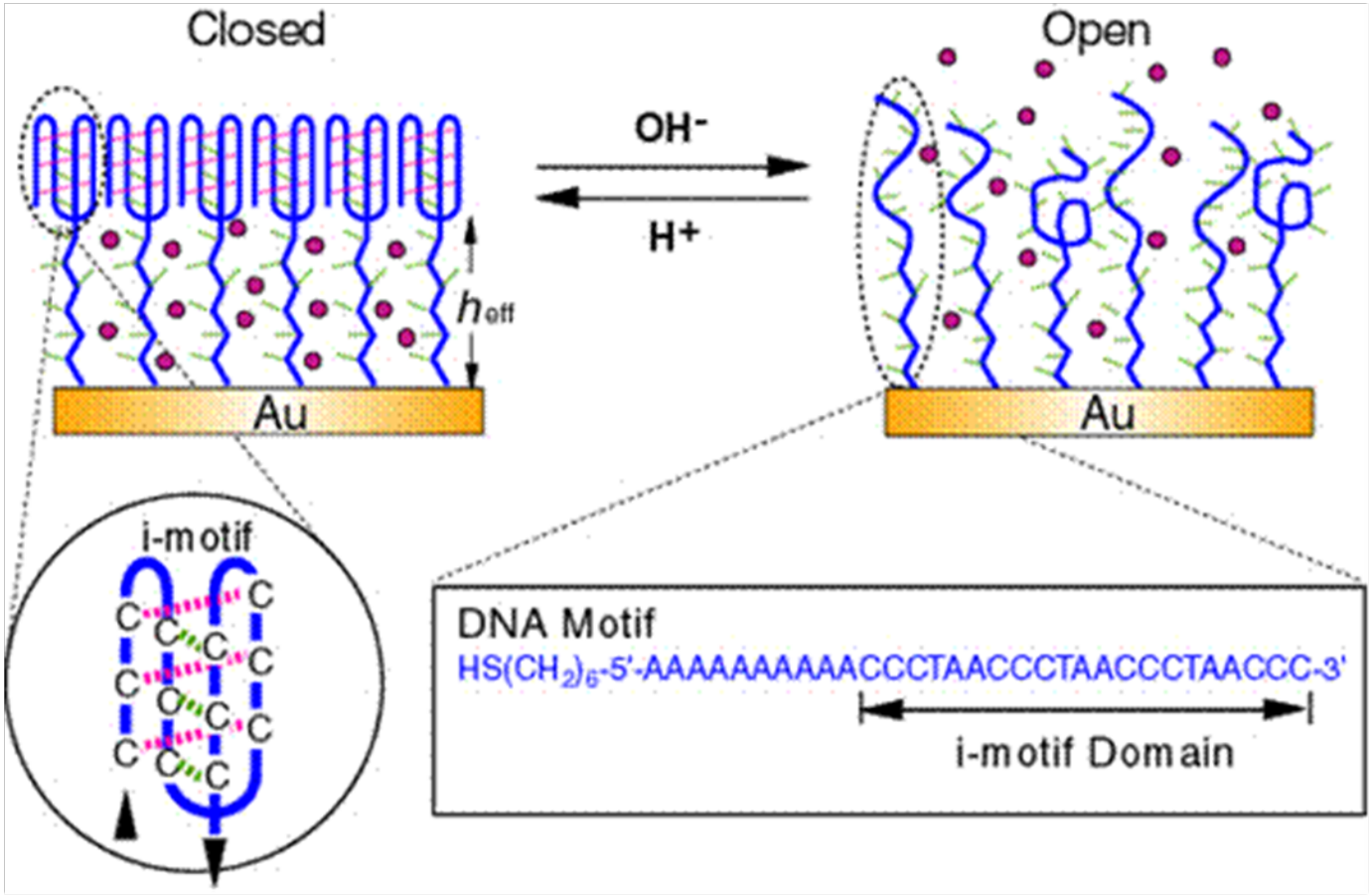


Challenges in DNA nanotechnology

- ✓ Can we make DNA machine!
- ✓ Yes, it can do work!
- What will it be used for?

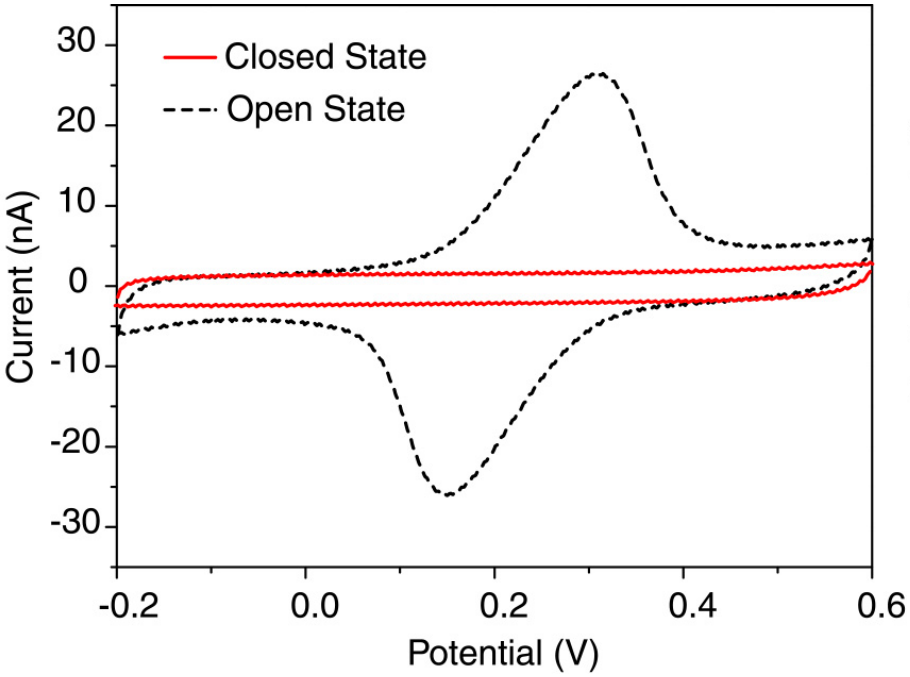
DNA Nanocontainer

***Nucleic Acids Research* 2007; *35*, e33**

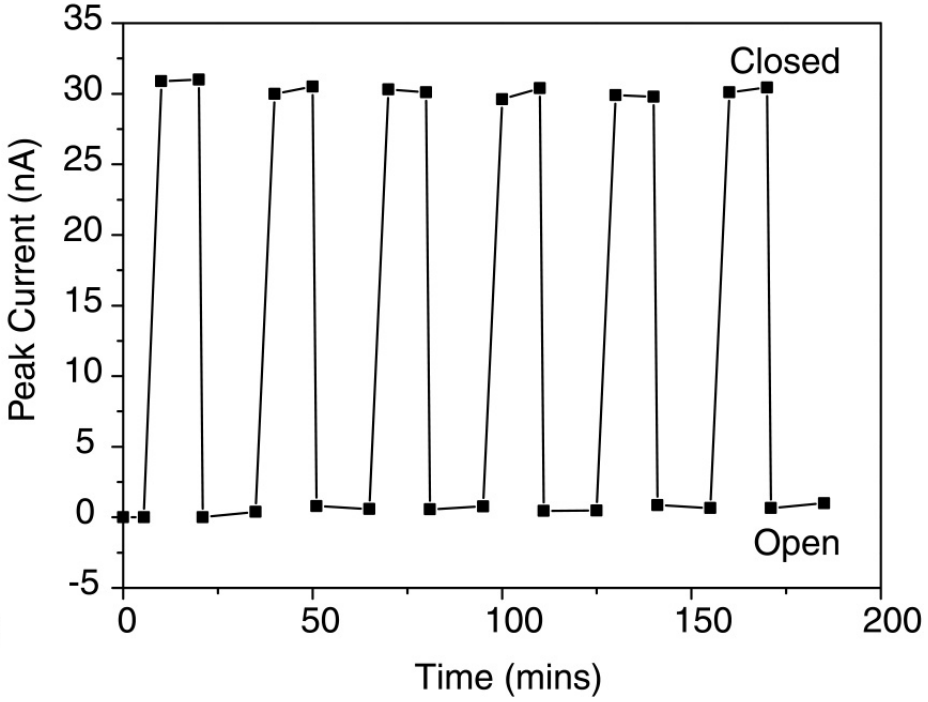


- $=Fe(CN)_6^{3-}$

Cycling the device



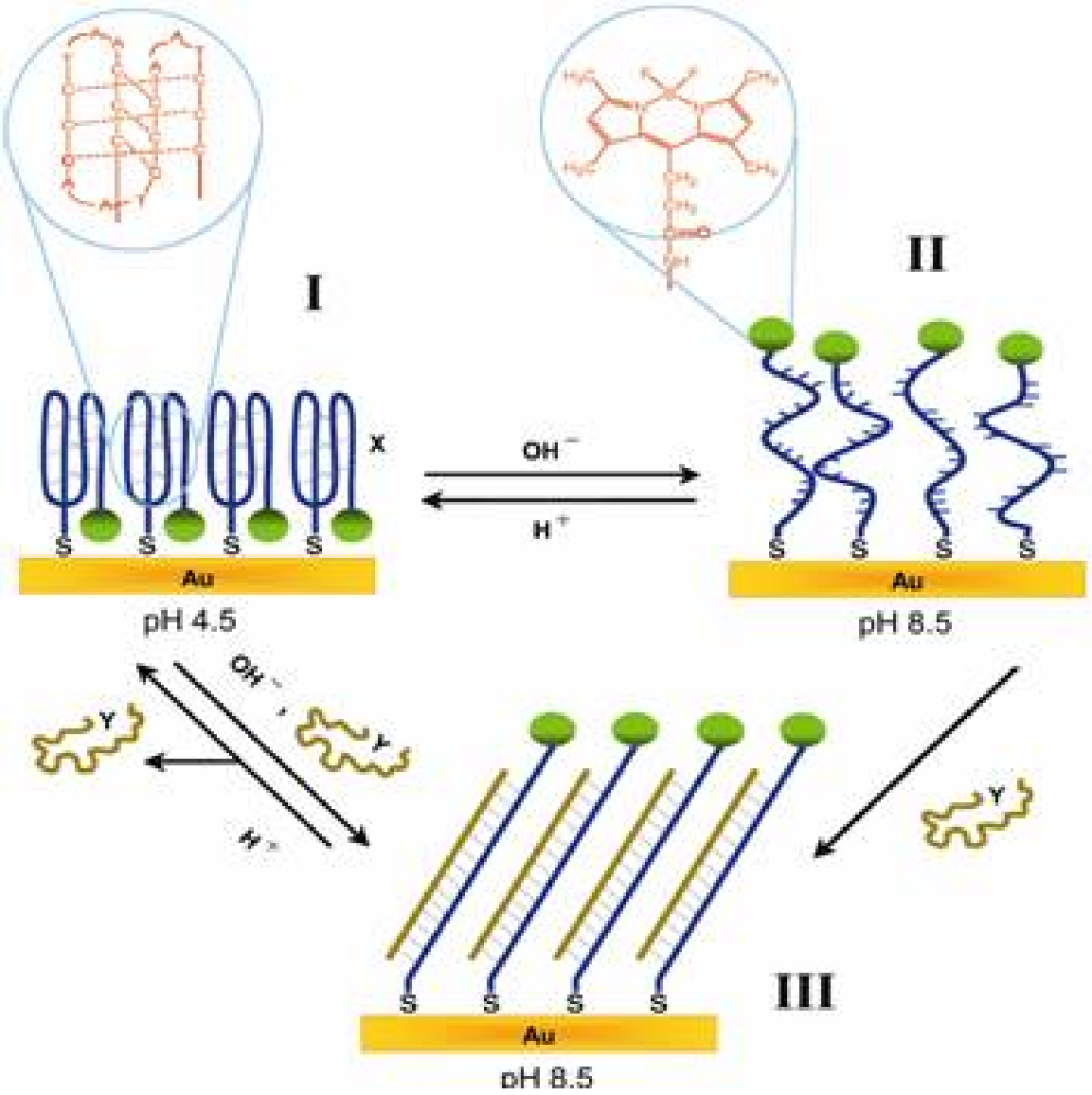
Cyclic voltammogram for the closed and open states of the device



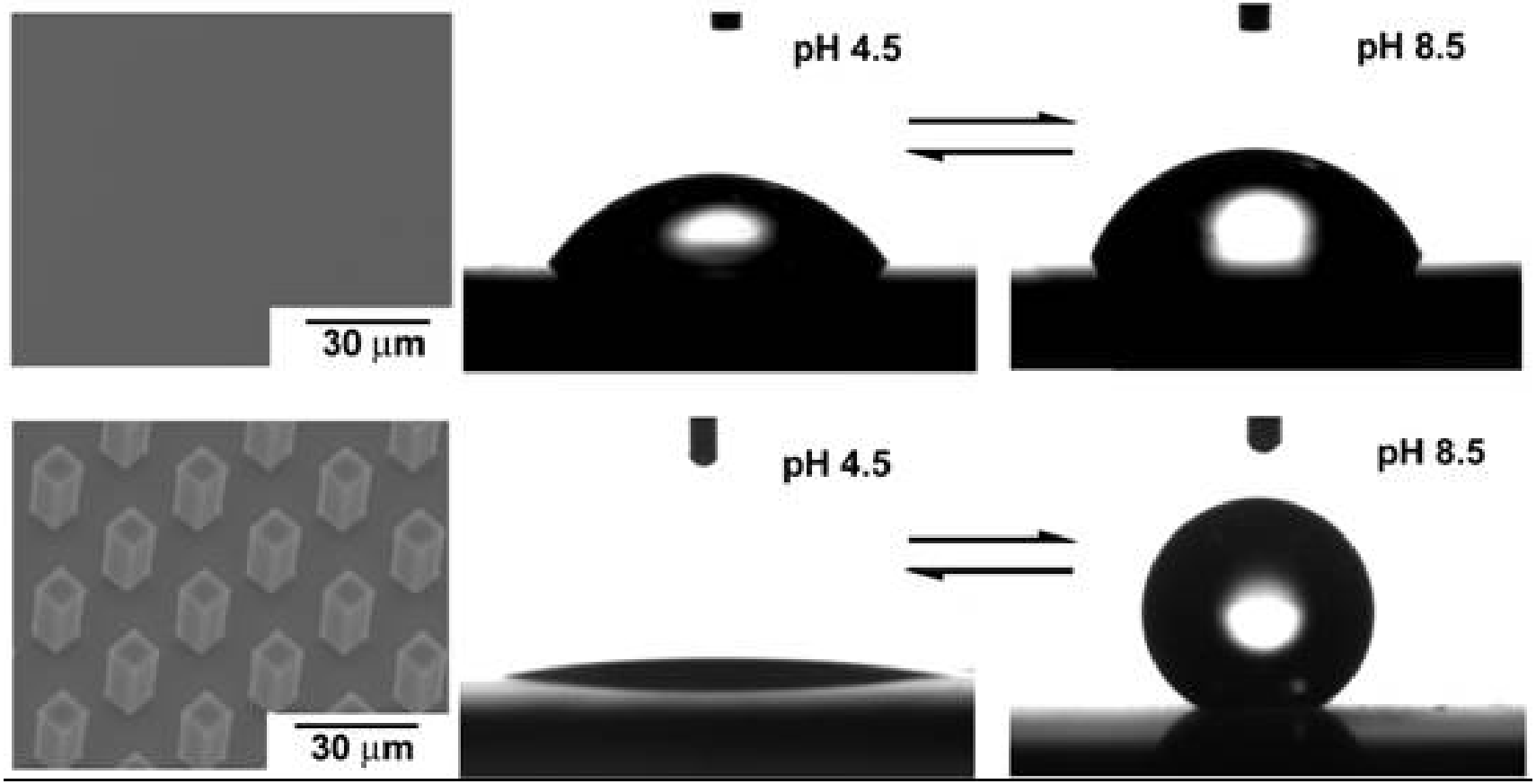
Re-use the device

Smart surface based on DNA motor

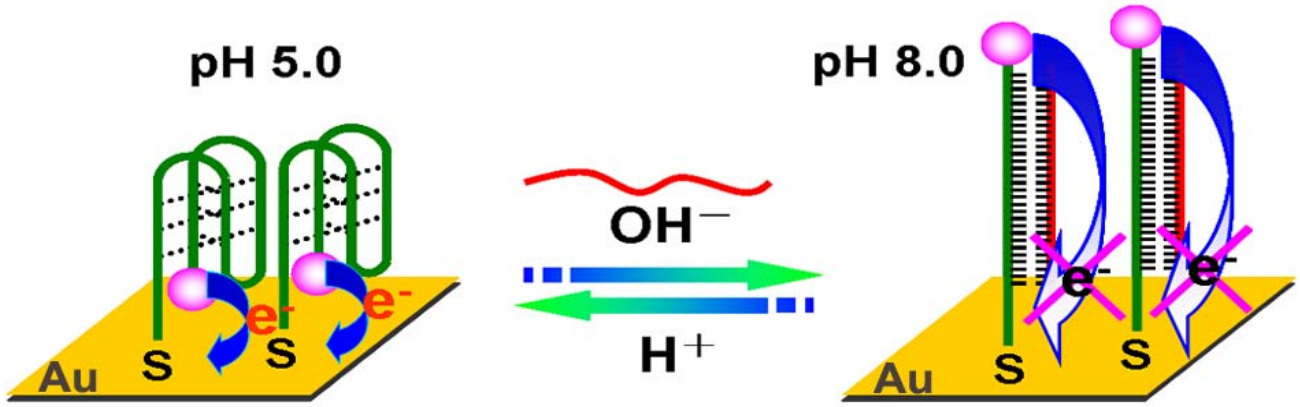
Angew. Chem., Int. Ed. 46, 3915-3917

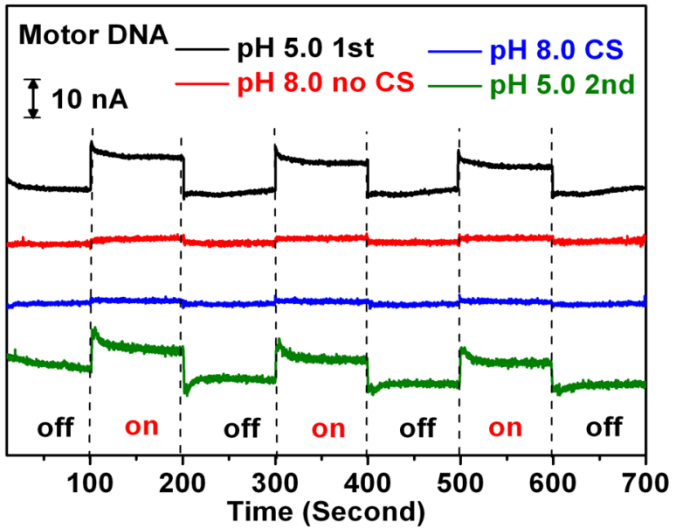


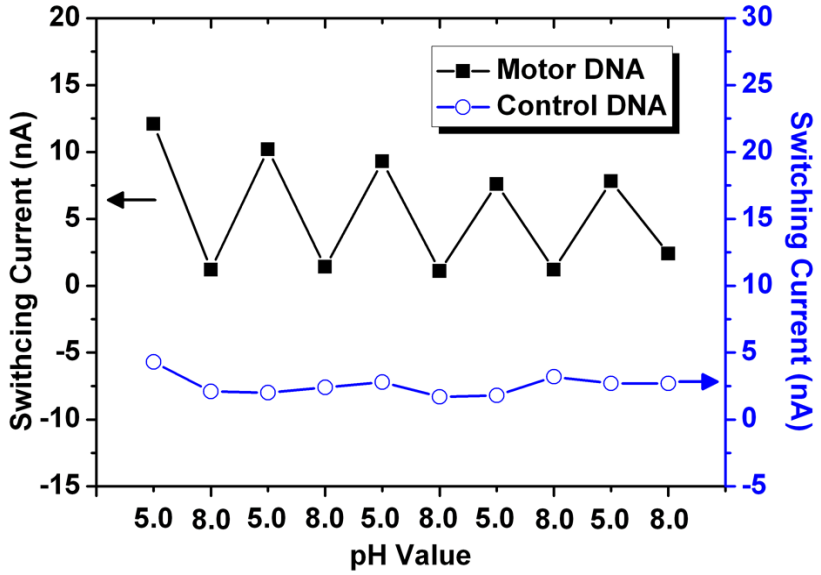
Smart surface based on DNA motor



Photoelectric Conversion Switch Based on Quantum Dots with i-motif DNA Scaffolds







Chem. Commun., **2009**, 2293–2295

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DNA 16, June 7-11, 2010, in Hong Kong University of Science and Technology

Chair: **Yongli Mi** (HKUST); Co-Chair: **Dongsheng Liu**

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  Chinese, Western, Asian, or anything you want.

* For shopping
  - Shopper's paradise

We are looking forward to seeing you!

Please contact DNA@nanoctr.cn for further information