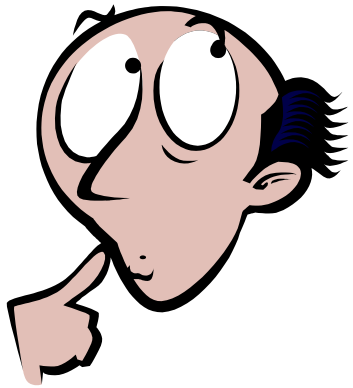
Dr. Wujian Miao Research Group

Department of Chemistry and Biochemistry

September 9, 2004

Who is
Dr. Wujian Miao?



- New Faculty Member
- Education and Research Background
- Website

  www.usm.edu/electrochem/

  Google Search

  www.google.com

Publications

- 1 US Patent
- Several Book Chapters
- 21 Papers in Scientific Journals
- 14 Proceedings of Conferences
- 4 Australian National Lab Divisional Publications

Major Journals with Our Papers

- American Chemical Society Journals

  http://pubs.acs.org/about.html

3 in *Analytical Chemistry*

5 in *Journal of Physical Chemistry*

2 in *Journal of the American Society*

1 in *Langmuir*

Other Journals

- 1 in *Analytica Chemica Acta*
- 1 in *Journal of Electroanalytical Chemistry*
- 4 in *Journal of Instrumental Analysis*

- *Analytical Chemist*

  → *Electrochemist*

Research Interests

- Analytical Chemistry
- Electrochemistry
- Electroanalytical Chemistry
- Surface Chemistry
- *Bioanalytical Chemistry.

DNA and Protein

Detection and Determination

Electrochemical Techniques

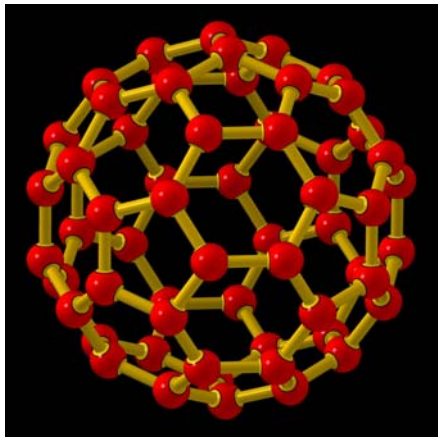
- Scanning Electrochemical Microscopy (SECM)
- Electrogenerated Chemiluminescence (ECL)
- Electrochemical Quartz Crystal Microbalance (EQCM)
- Electrochemical Impedance Spectroscopy (EIS)
- Combinations of the Above

Other Techniques

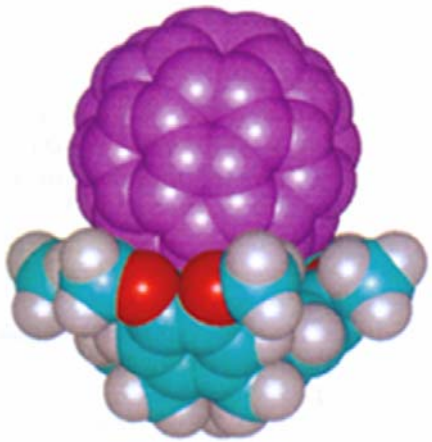
- UV-Visible Spectroscopy
- Fluorescence
- Scanning Electron Microscopy (SEM)
- Transmission Electron Microscopy (TEM)
- ……

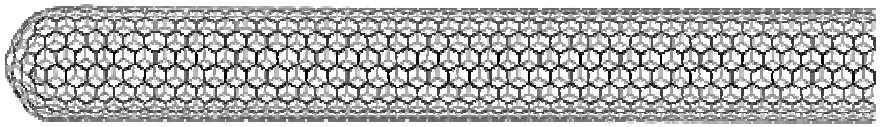
Examples of Research Projects

1. Solution-phase and solid-state electrochemistry

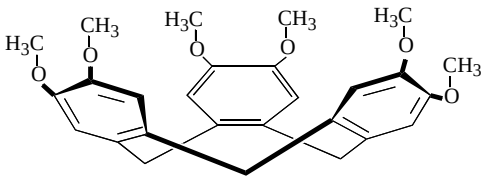


C_{60}

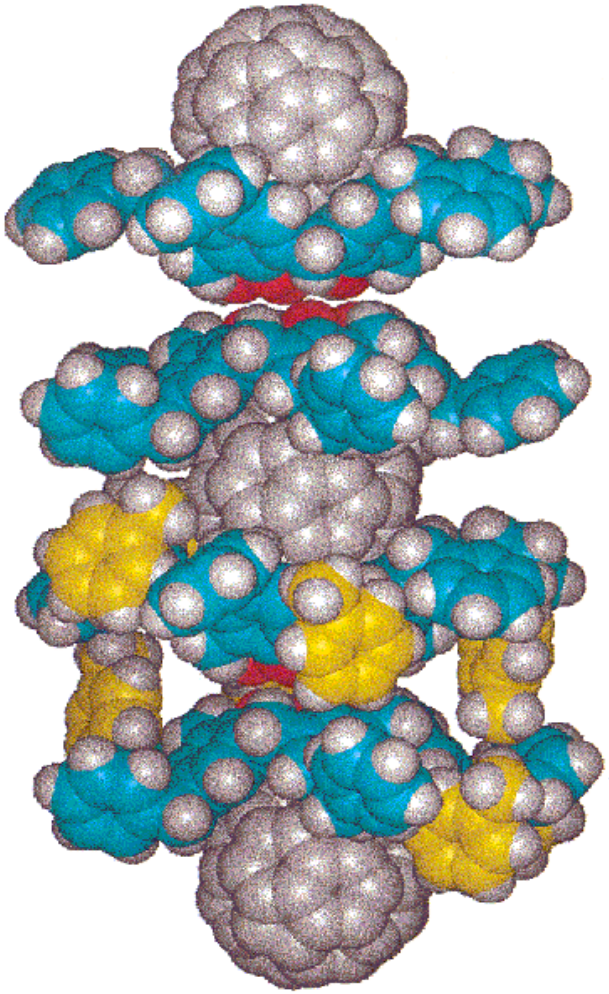




Carbon Nanotubes



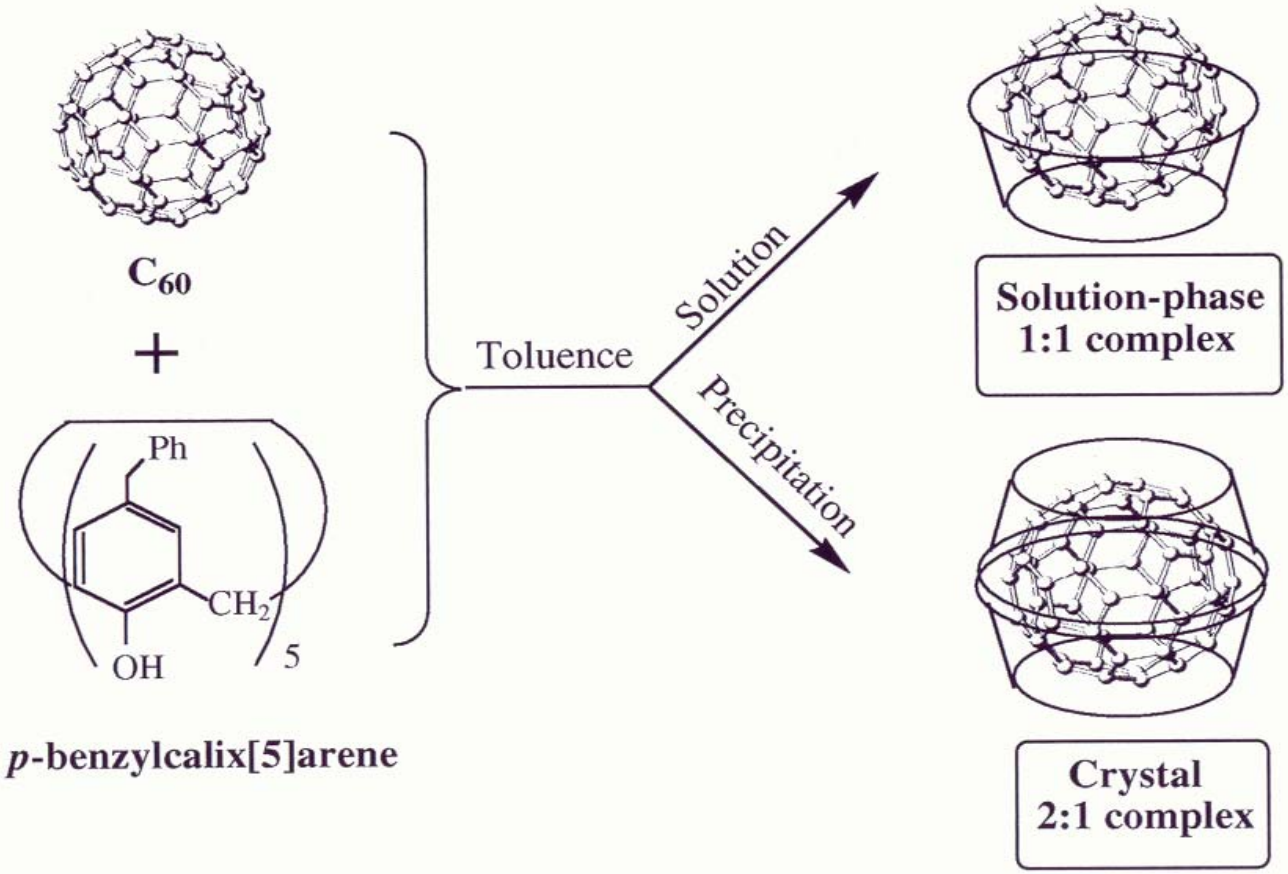
CTV

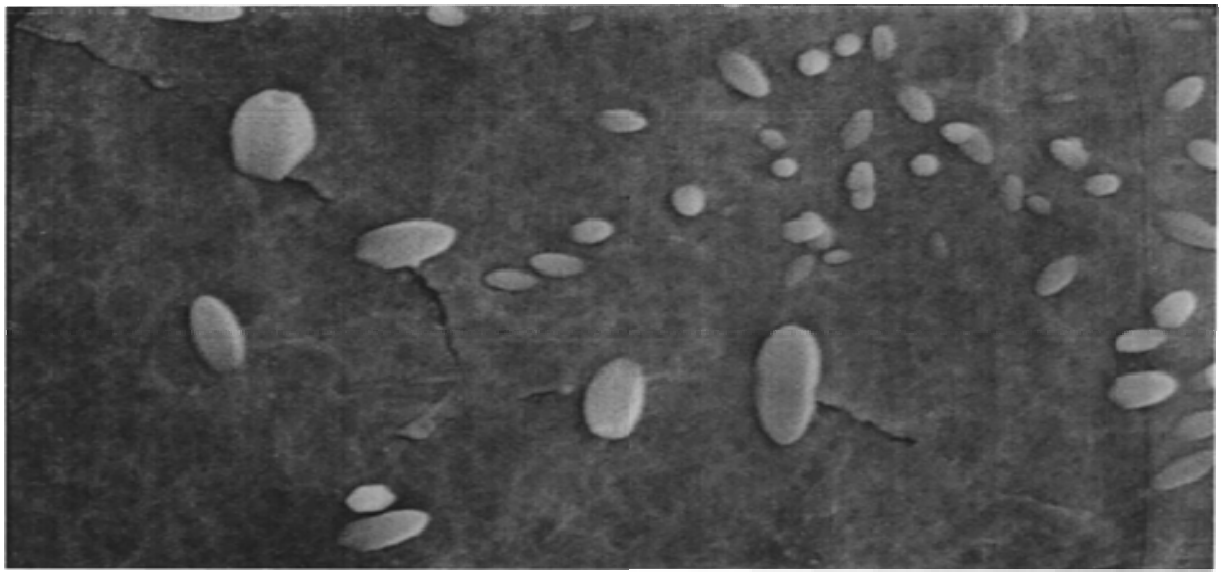


(b)

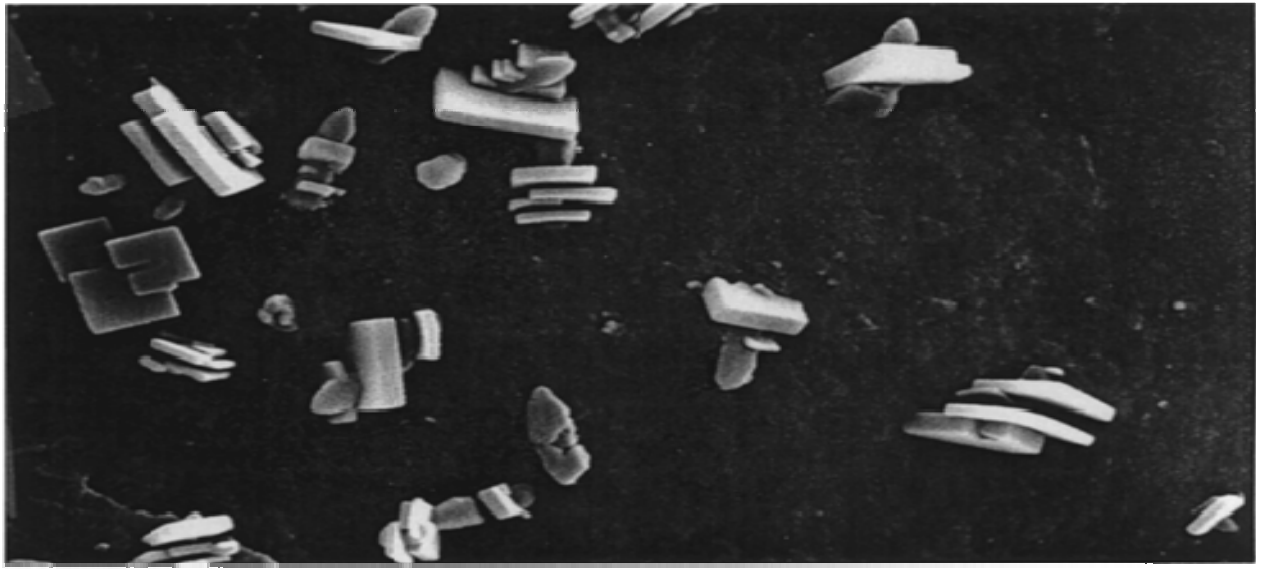
Calix(5)arene-C_{60}

Preparation of crystalline (p-benzylcalix[5]arene)$_2$-C_{60} (2:1complex)





(a)



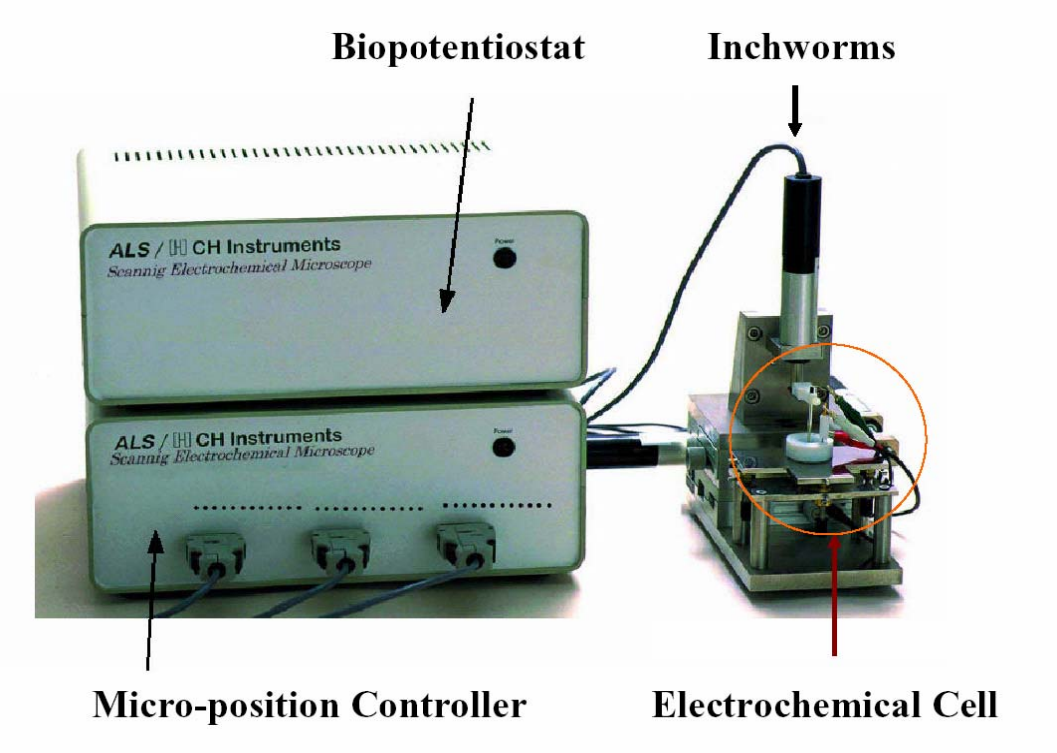
(b)

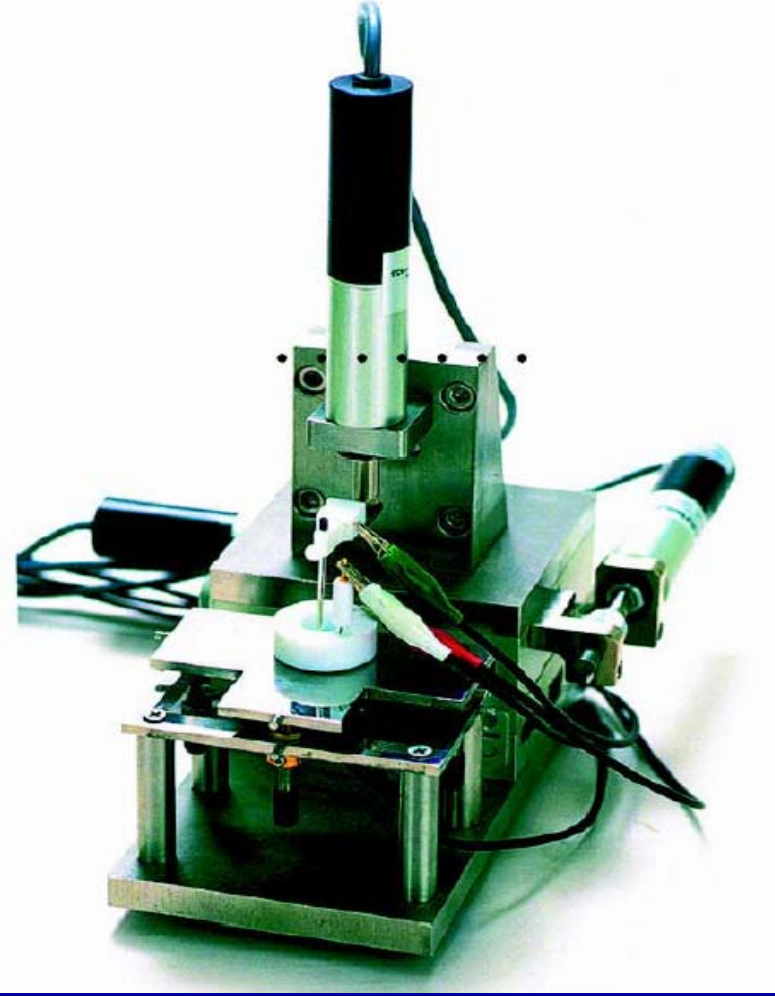
5 μm

Examples of Research Projects

2. Bacteria Respiration Examination with SECM

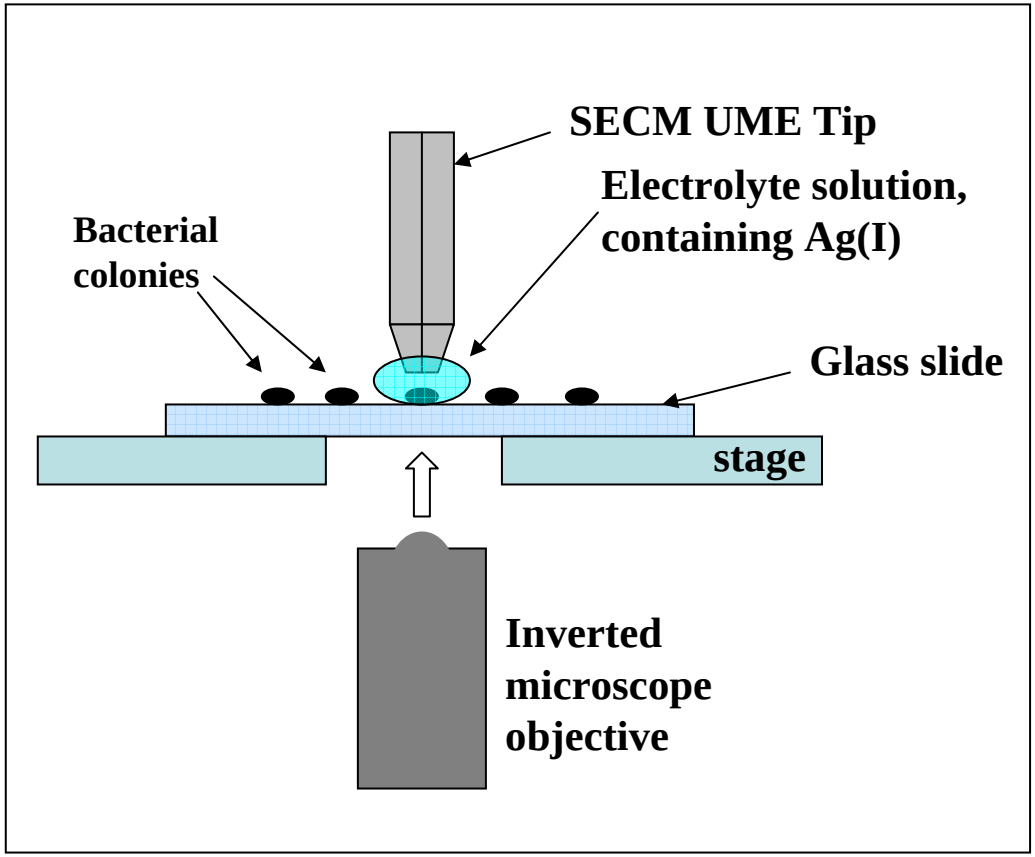
Experimental Set Up

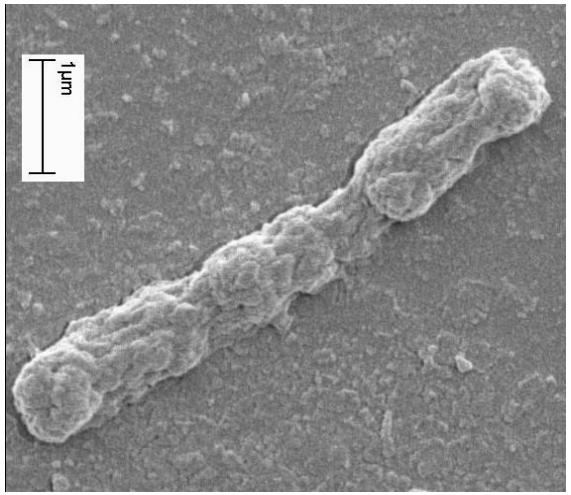


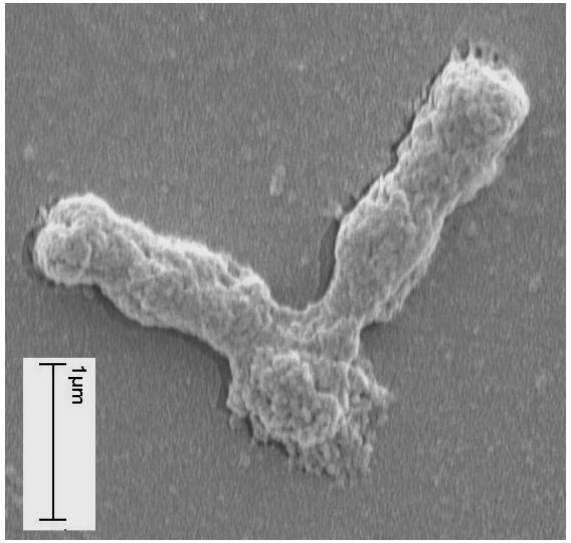


SECM

Scanning Electrochemical Microscopy of Immobilized Bacteria







Examples of Research Projects

3. Biosensors Based on ECL

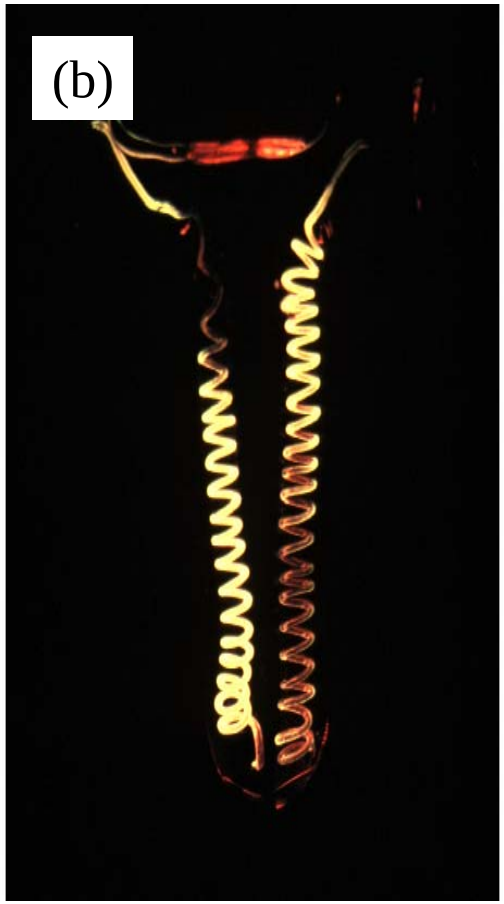
Chemiluminescence (CL)—Cool light

Reactions
that produce light
without heat
are called
Chemiluminescent
(CL) Reactions

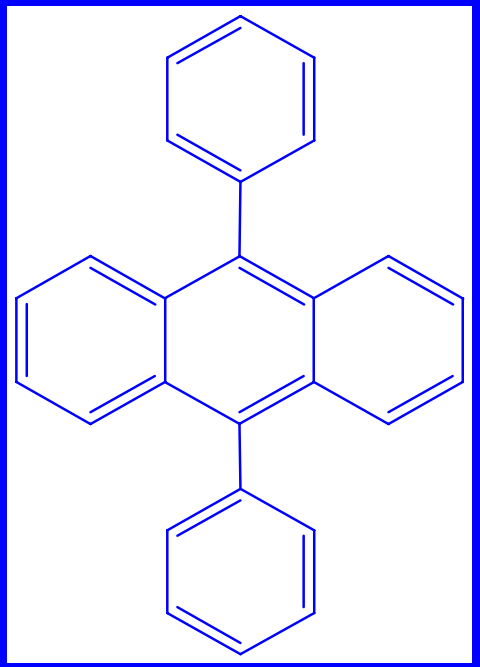
Electrogenerated Chemiluminescence

Before (a) and After (b) Applying of Potentials

Rubrene in MeCN

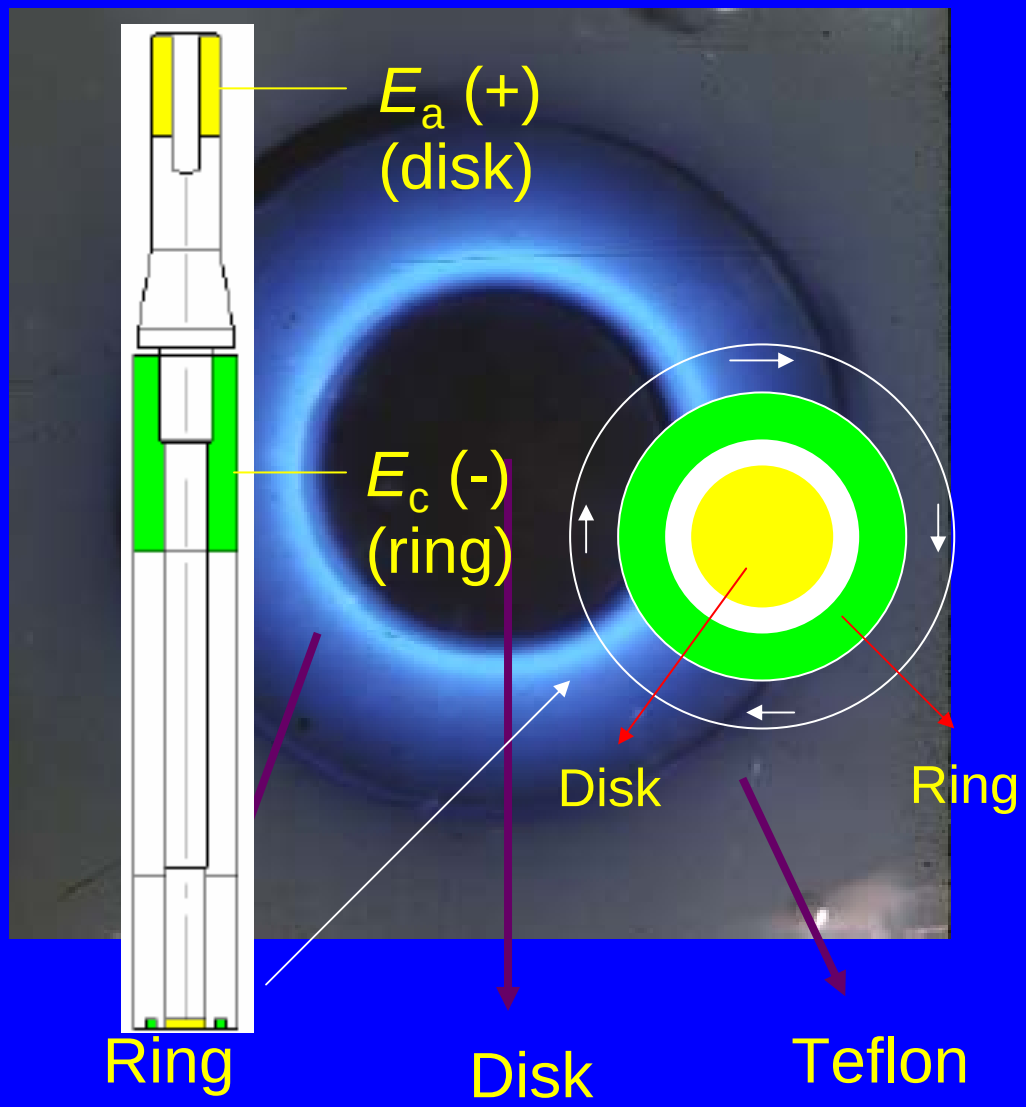


9,10-diphenylanthracence in MeCN at Rotating Ring Disk Electrode

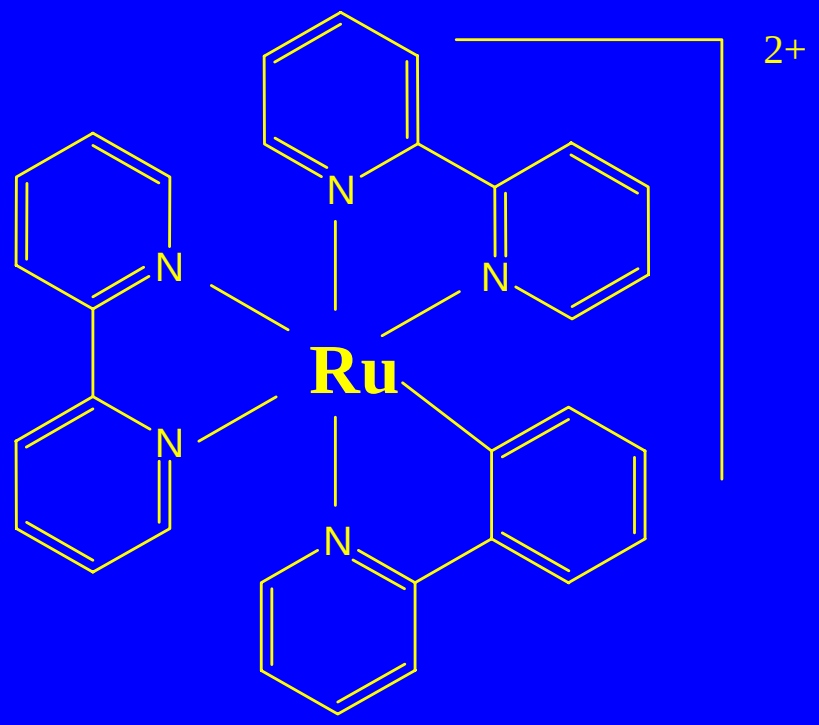


(DPA)

E_s = 3.0 eV
l ~ 410 nm



Coreactant ECL



$Ru(bpy)_3^{2+}$

$(CH_3CH_2CH_2)_3N$:

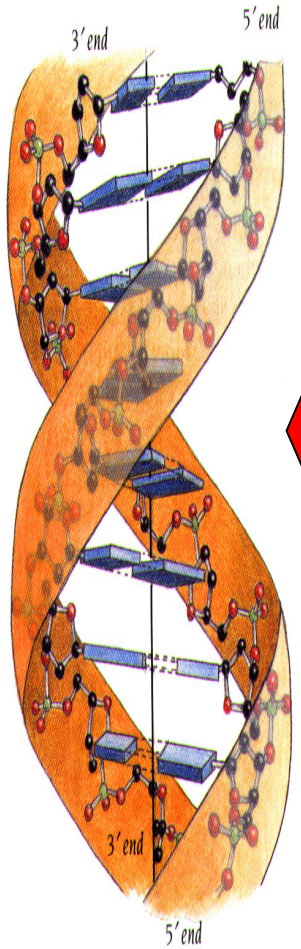
(***T***ri***Pr***opyl ***A***mine)

TPrA

(As coreactant)

This System Gives the Most Efficient ECL Known So Far.

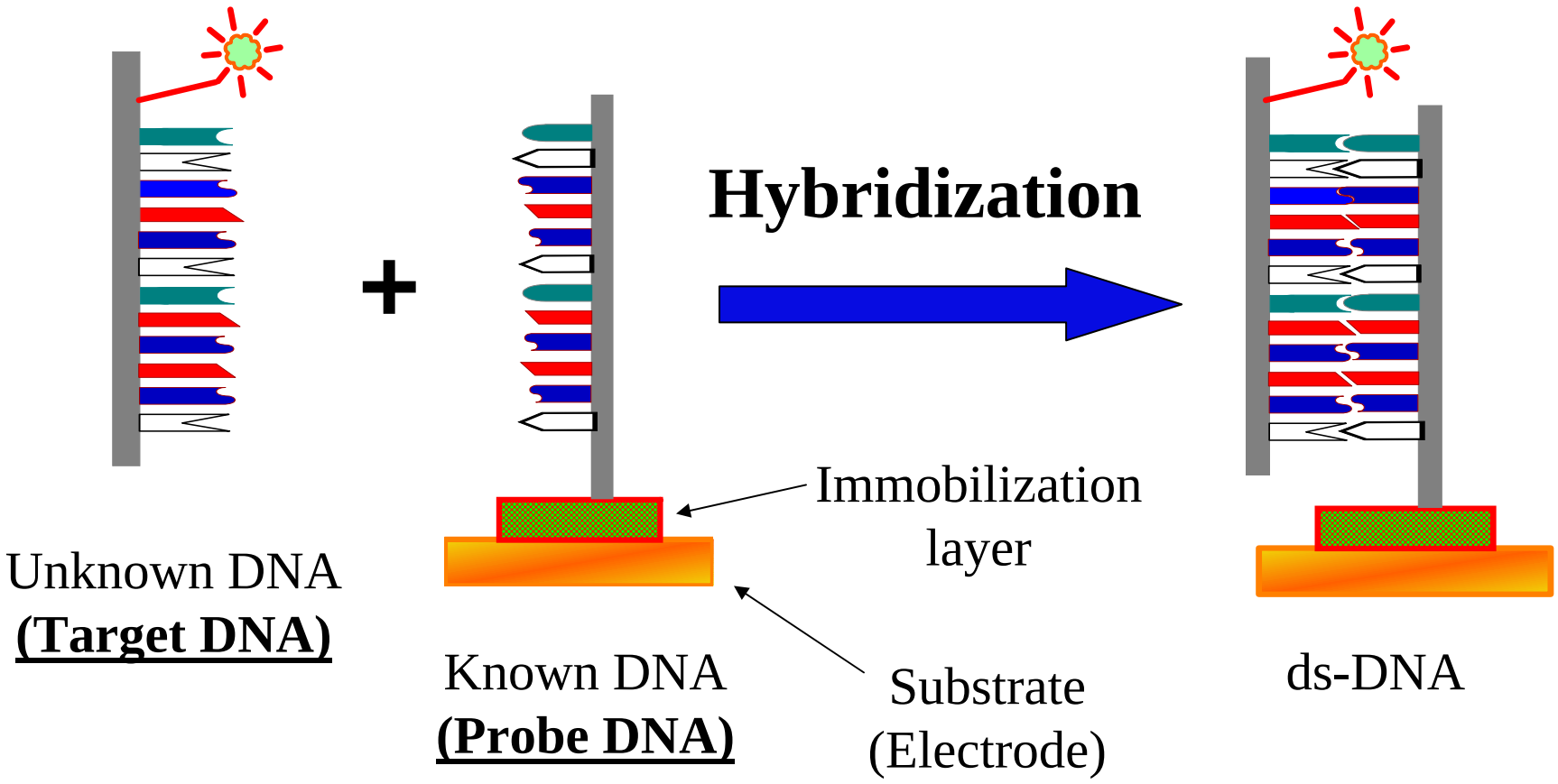
ECL Applications



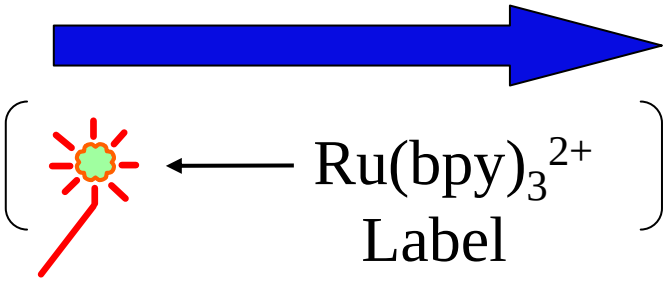
DNA

ECL

Antibody-Antigen

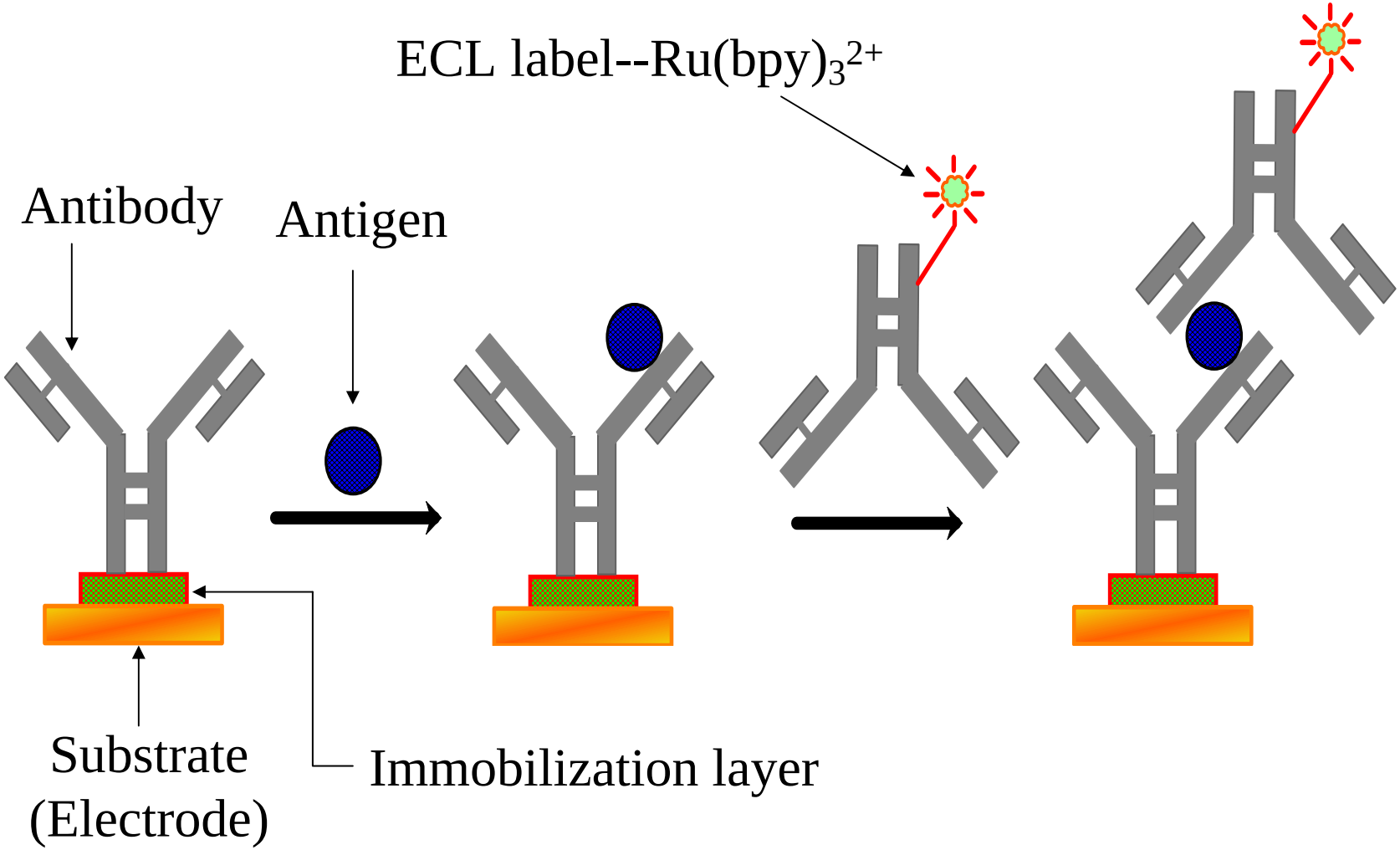


ECL Detection

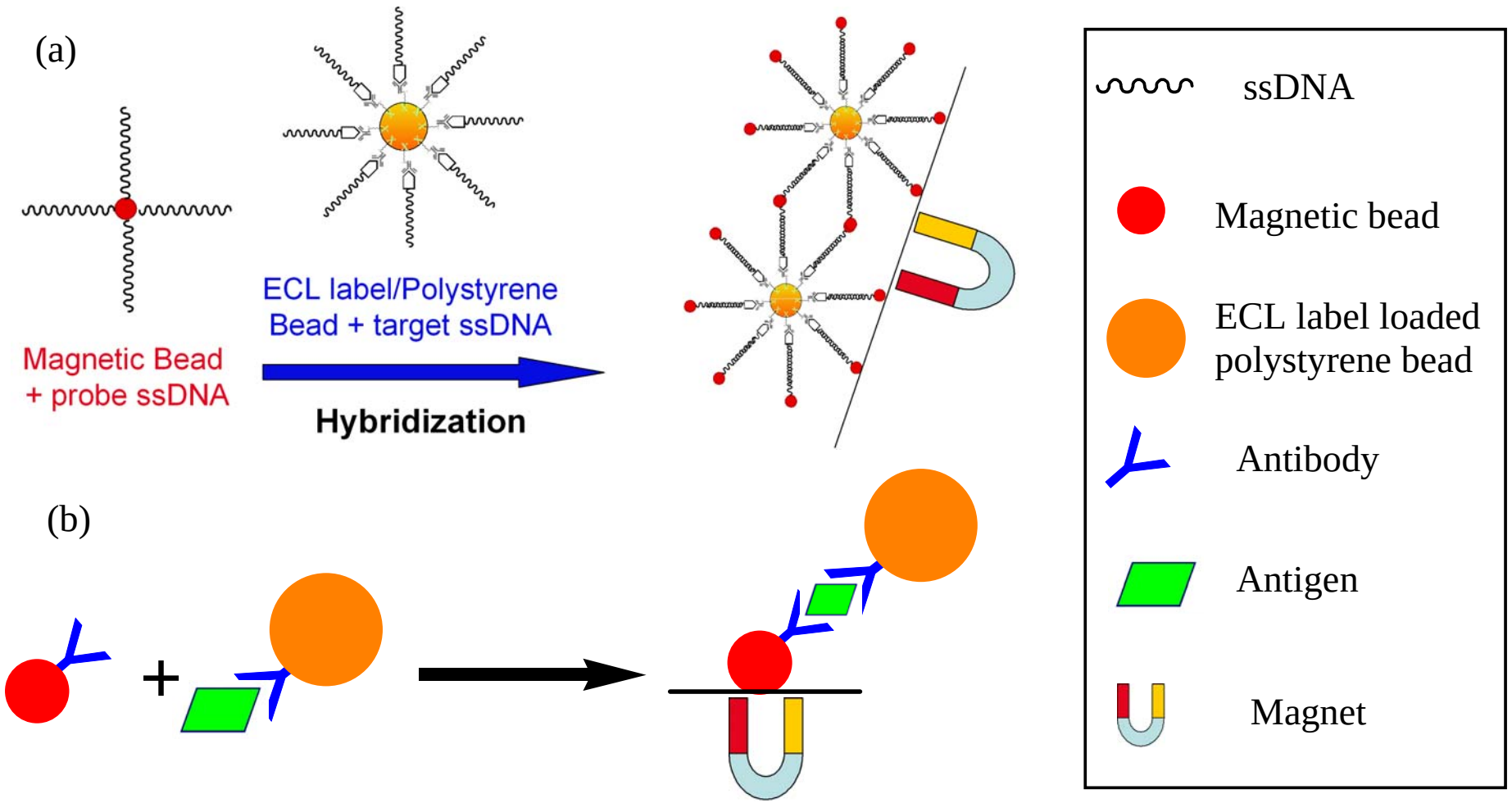


- Large I_{ECL} → Complementary
- Small I_{ECL} → Base-pair mismatched
- I_{ECL} ~ 0 → Non-complementary

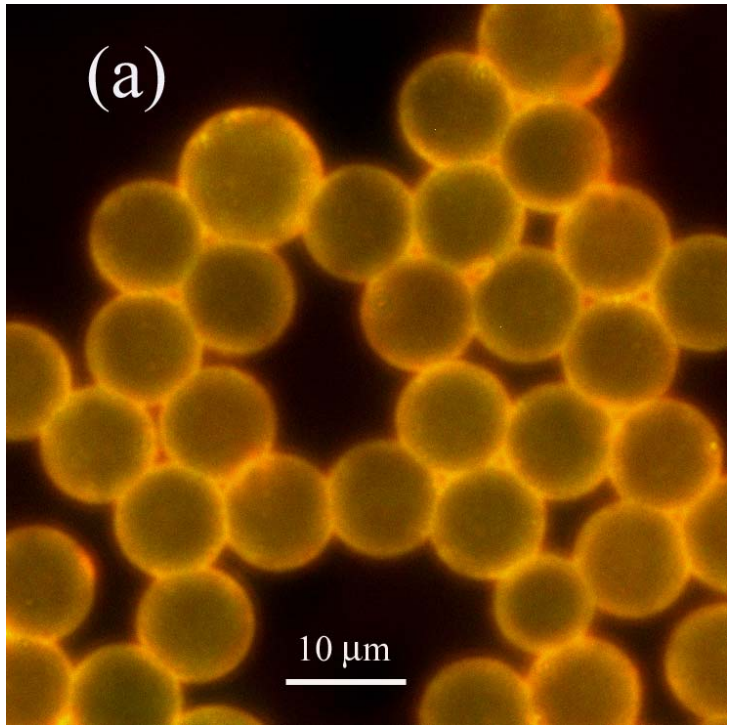
ECL Detection with Sandwich Type Immunoassay



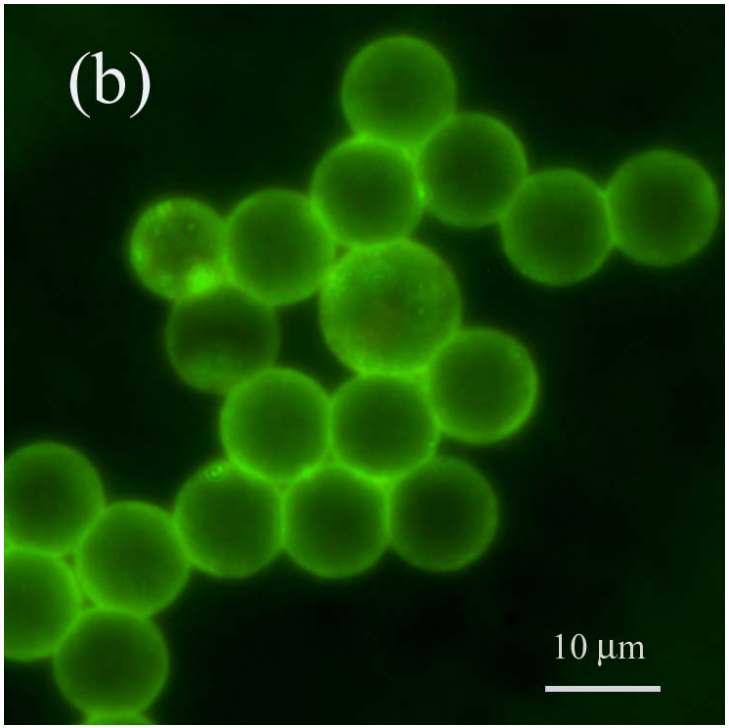
Our Strategies…



Fluorescent Images



After $Ru(bpy)_3^{2+}$ Loading

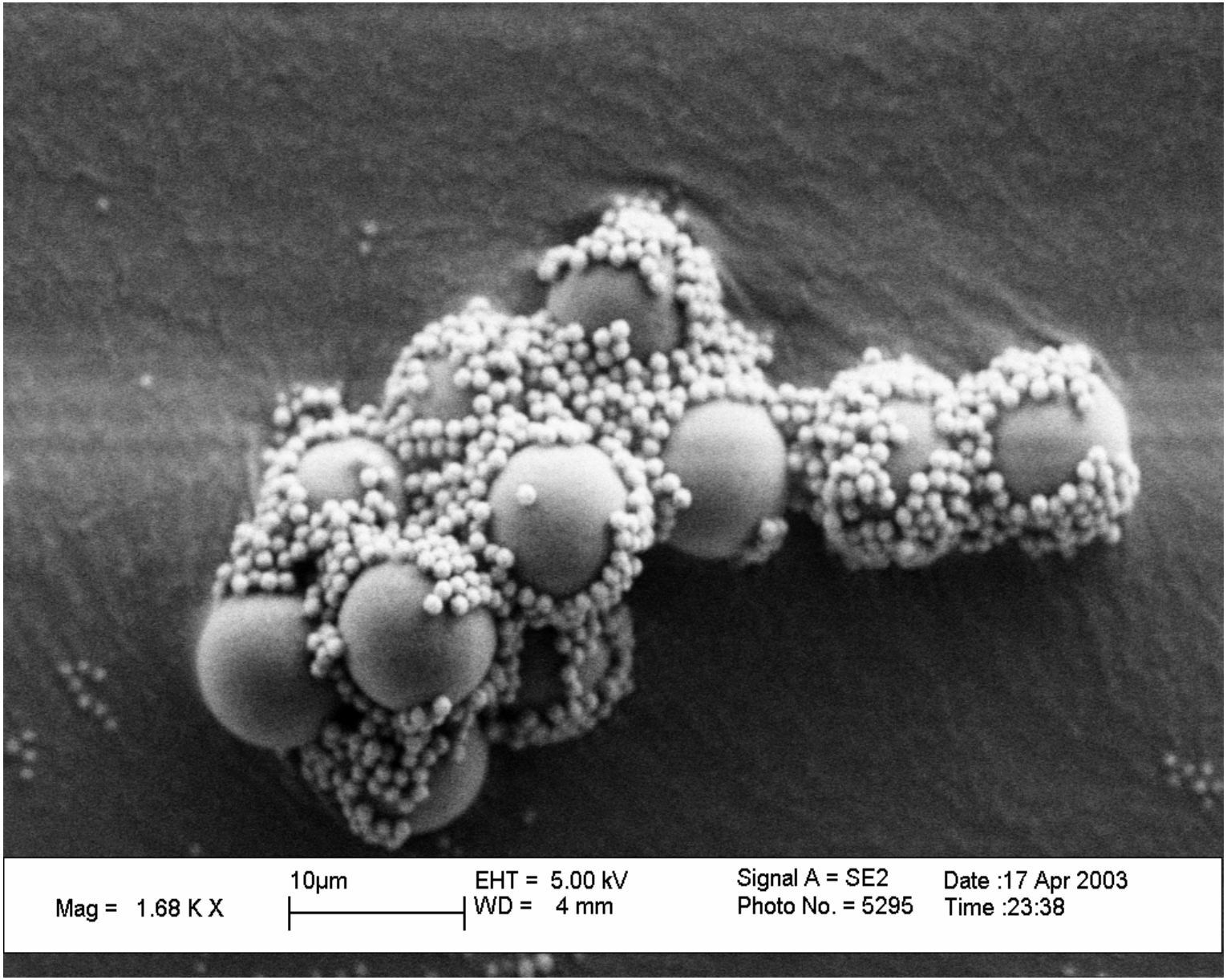


(a) + Avidin ← Fluorescein Biotin

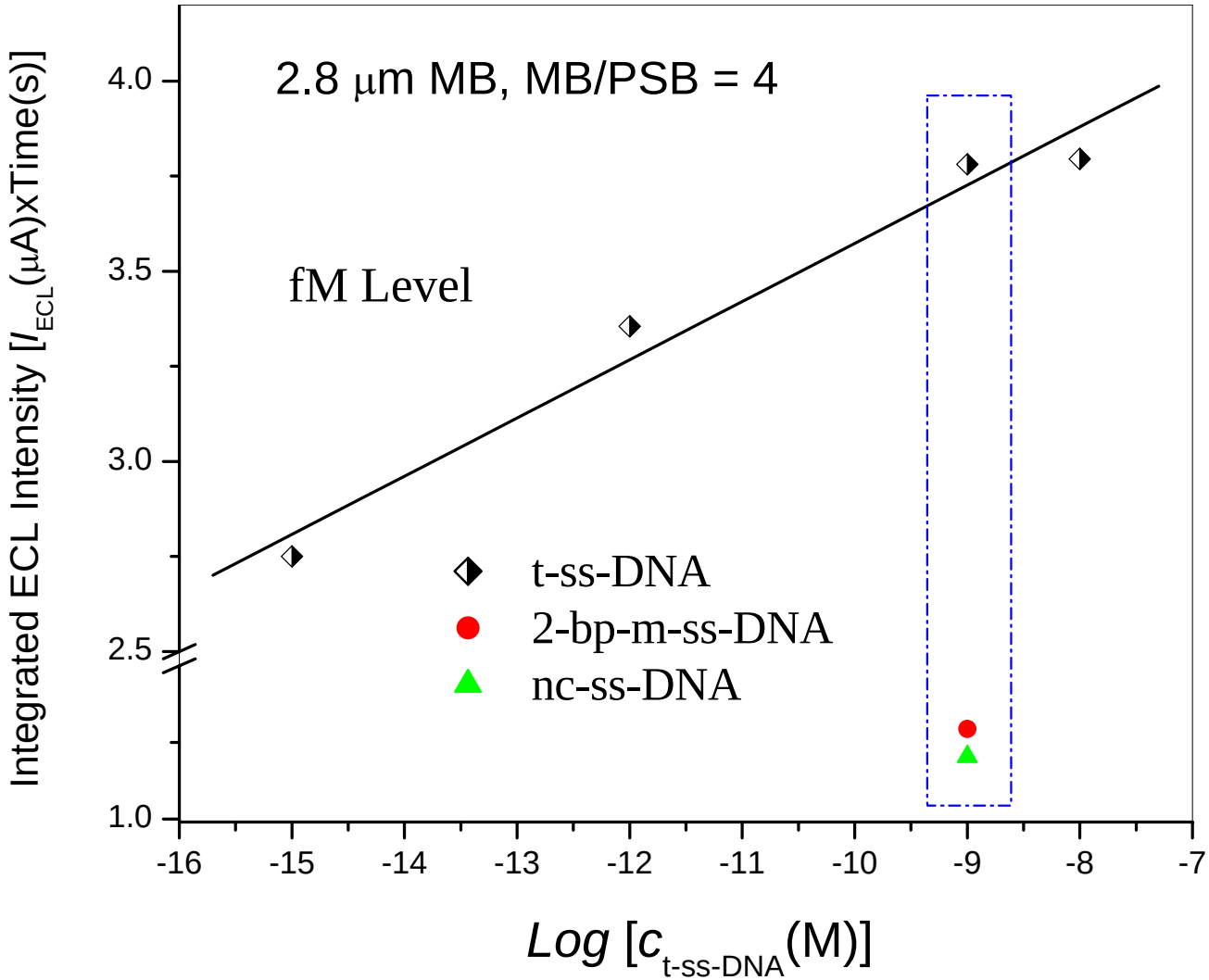
Loading capacity:
7×10^9 molecules/bead

Amplification factor:
7×10^9 $Ru(bpy)_3^{2+}$/1×10^5 ssDNA
70,000 $Ru(bpy)_3^{2+}$/ssDNA

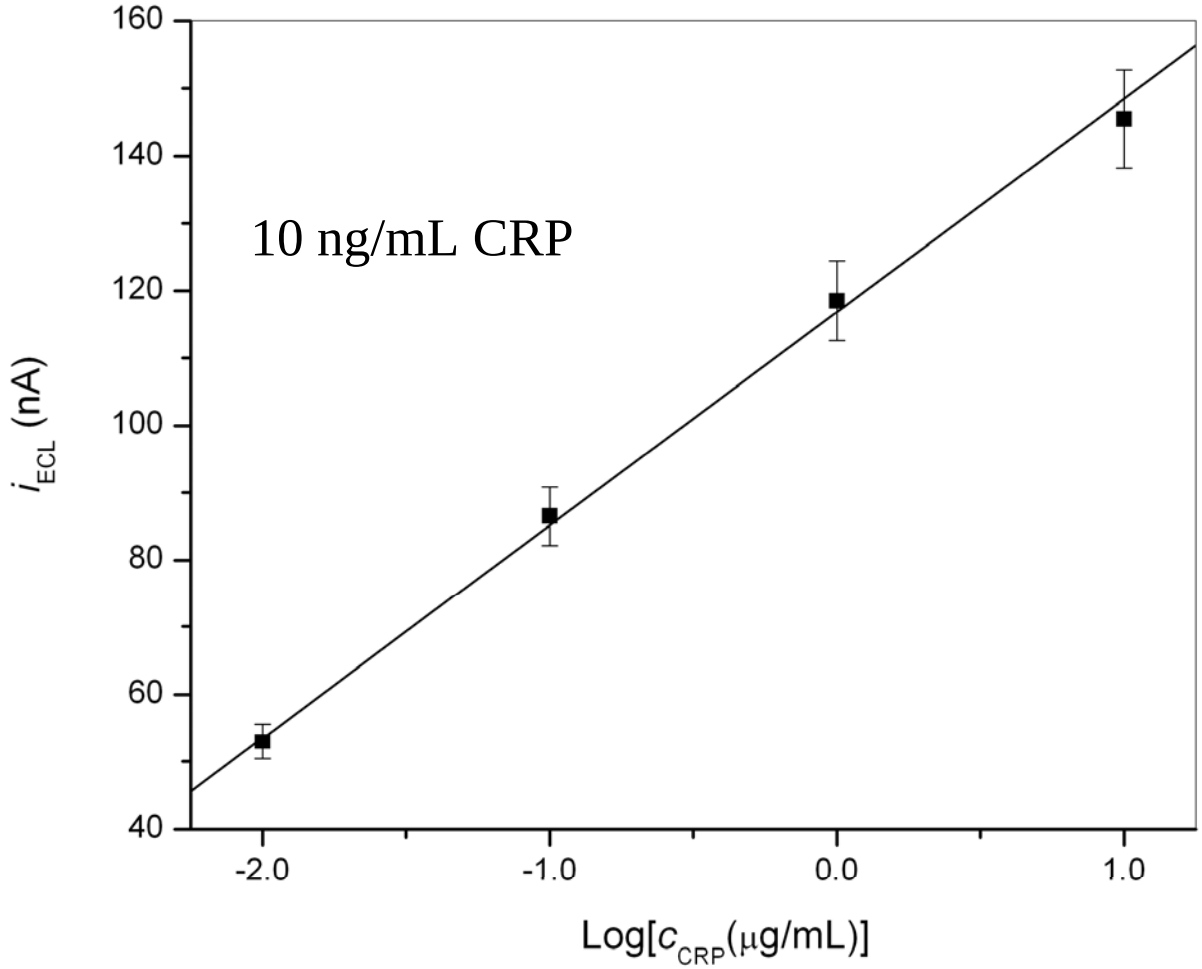
SEM Images of c-DNA Hybridization



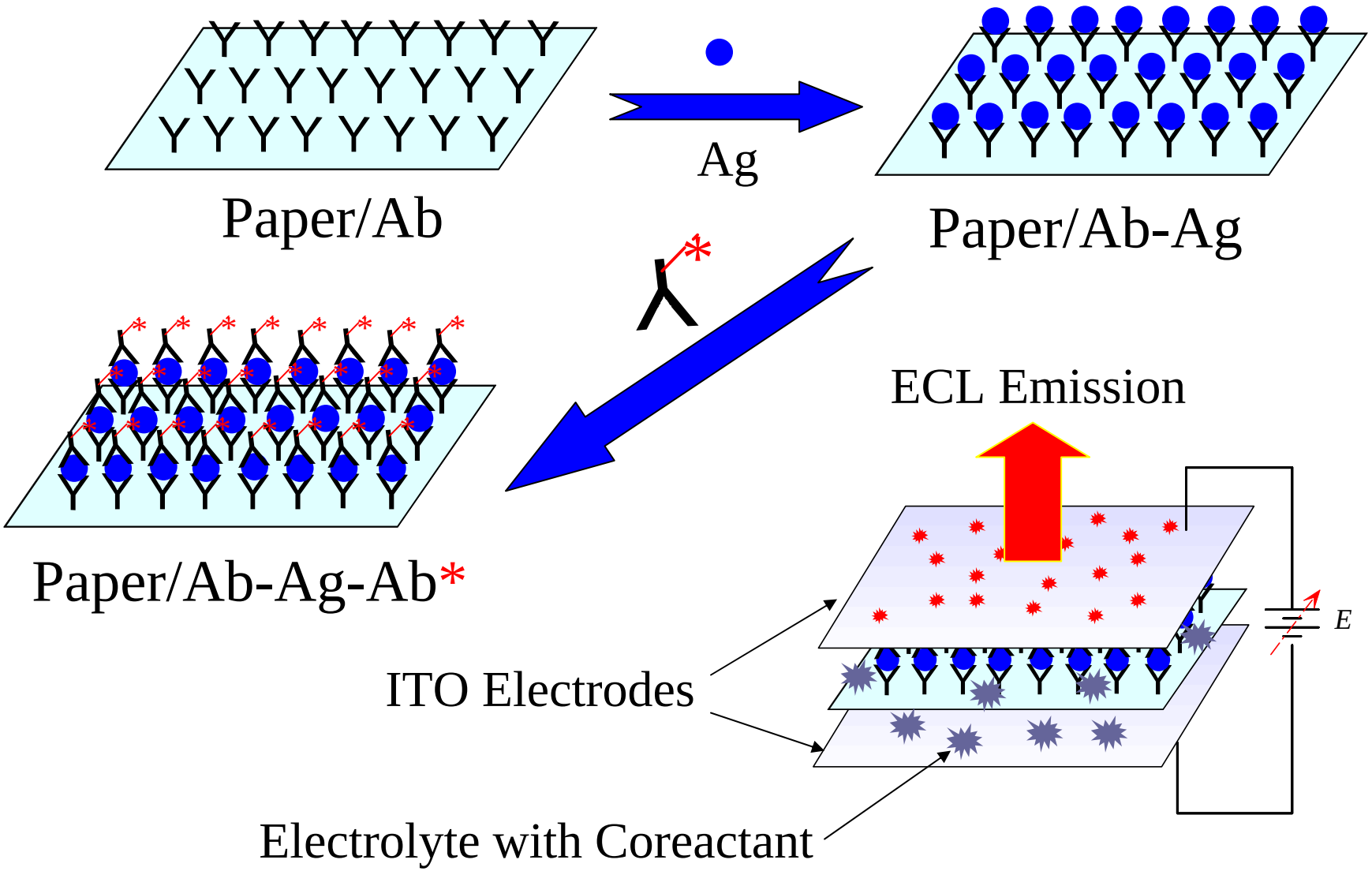
ECL Detection of DNA Hybridization Using $Ru(bpy)_3^{2+}$ Entrapped Microspheres



C-Reactive Protein Determination



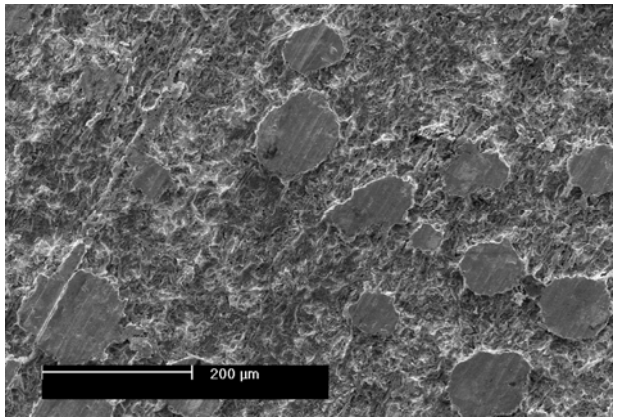
Disposable Paper Strip ECL Test System

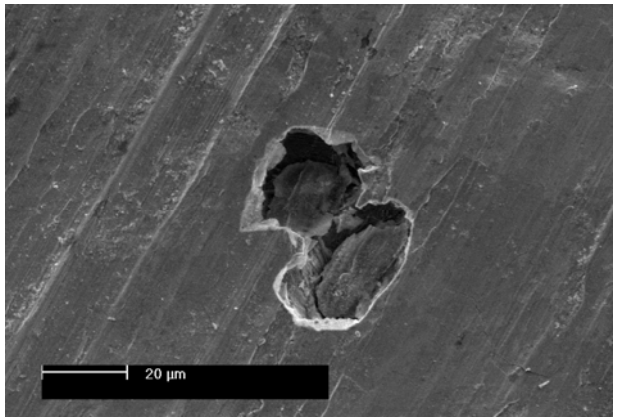


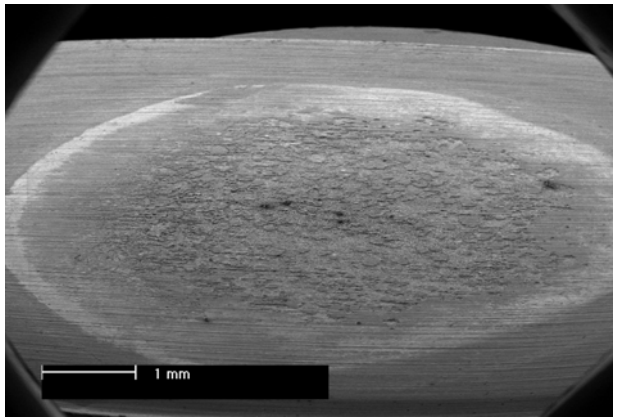
Examples of Research Projects

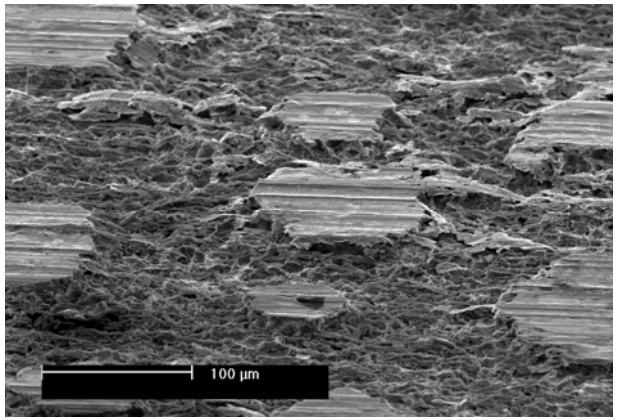
4. Corrosion Protection

Zinc metal “after formation of Corrosion product”

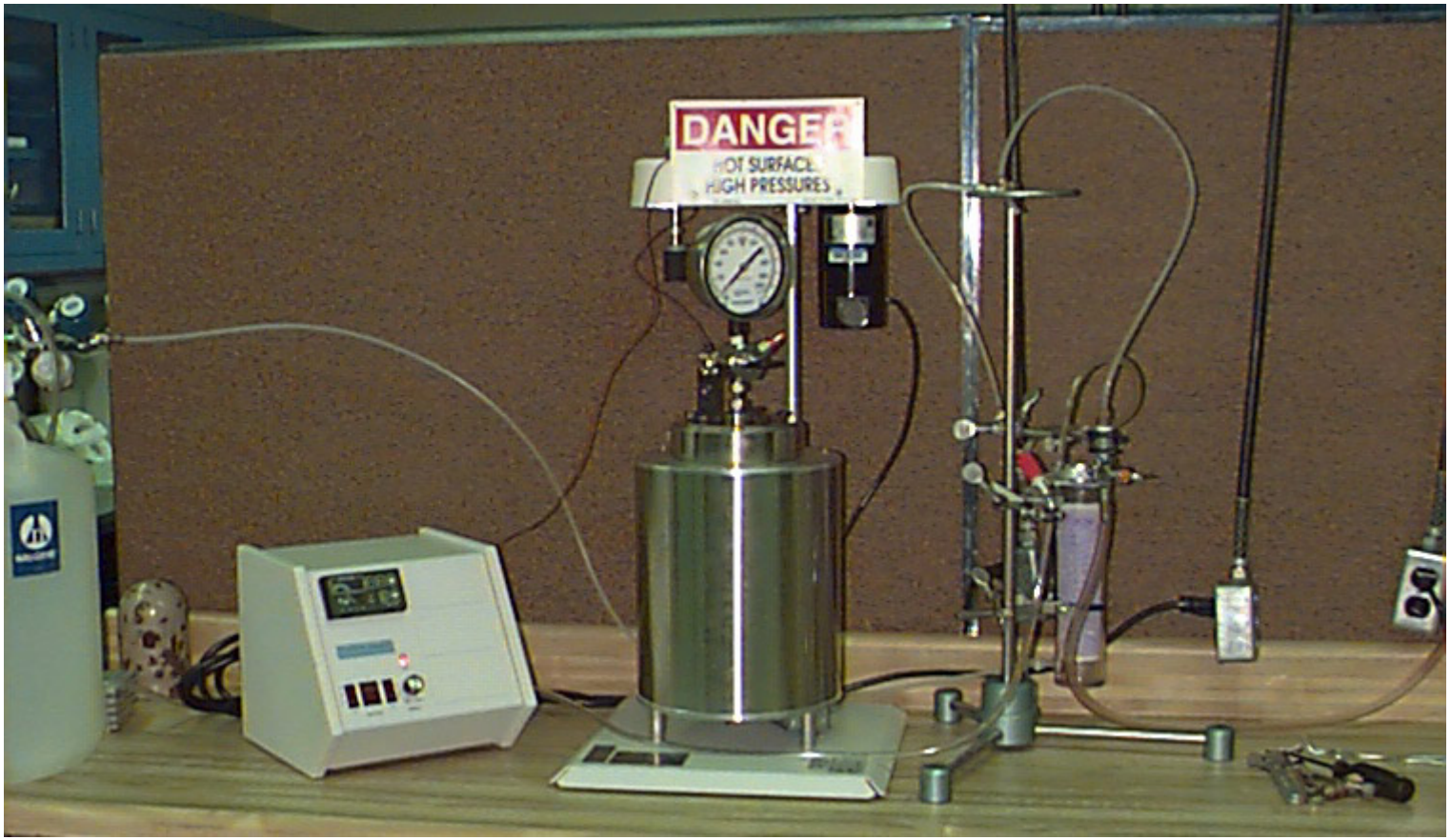








Synthesis of Rare Earth Oxide Nanoparticles



Hydrothermal Reactor

($CeCl_3$ with F^- at high *P* and High *T*)

Further Information?

- Visit

"Dr. Wujian Miao Research Group at USM"

Website:

www.usm.edu/electrochem/