INSTRUMENTAL TECHNIQUE PRESENTATION

SCANNING ELECTROCHEMICAL MICROSCOPY (SECM)

KRISHNADAS

23-08-14

SCANNING PROBE MICROSCOPY

Image the surfaces using a physical probe that scans the specimen

AFM, atomic force microscopy
BEEM,
ballistic electron emission microscopy
CFM, chemical force microscopy
C-AFM,
conductive atomic force microscopy
ECSTM
electrochemical scanning tunneling microscope

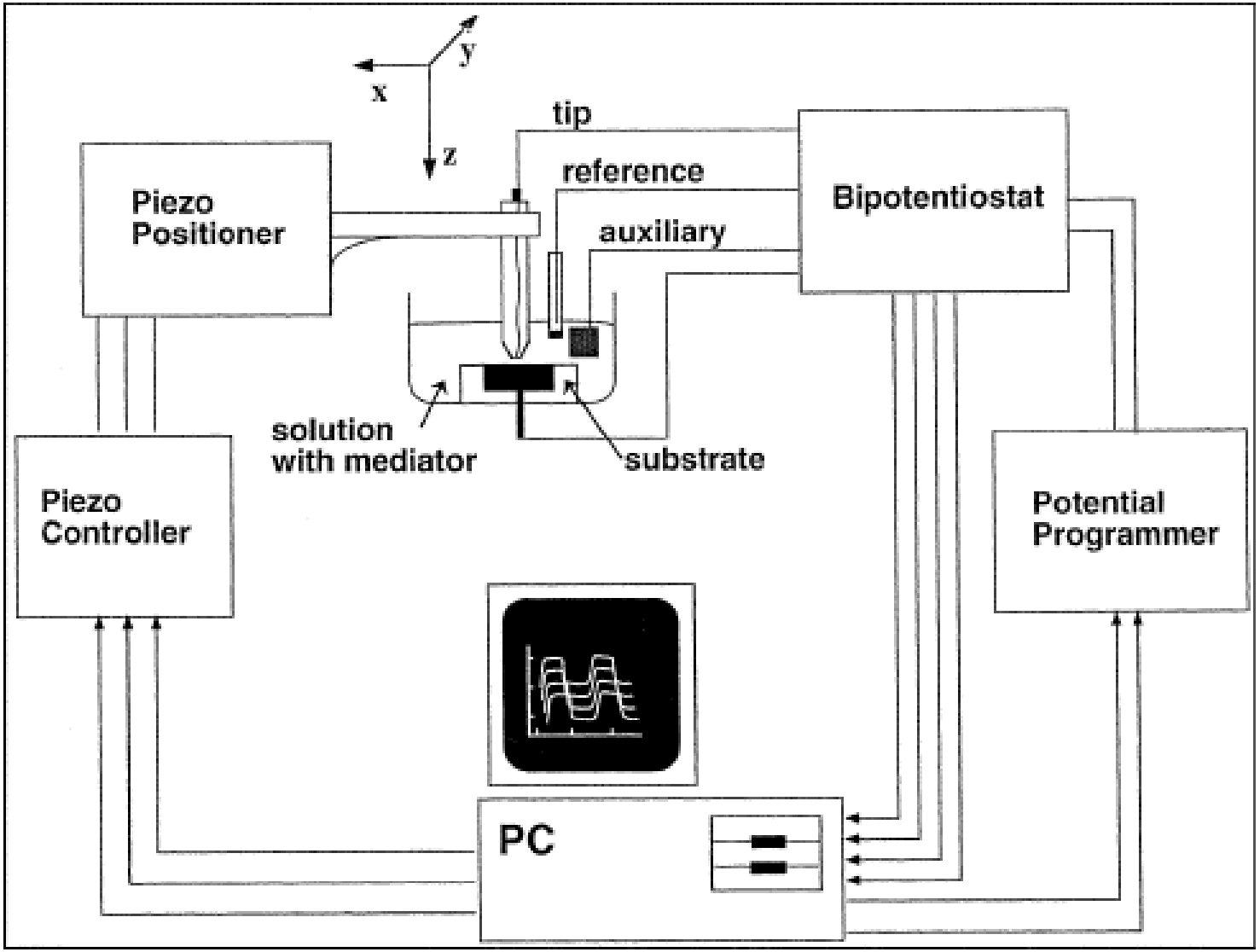
EFM, electrostatic force microscopy
FluidFM, fluidic force microscope
FMM, force modulation microscopy
FOSPM,
feature-oriented scanning probe microscopy

KPFM, kelvin probe force microscopy
MFM, magnetic force microscopy

PTMS, photothermal microspectroscopy /microscopy
SCM, scanning capacitance microscopy
SECM,
scanning electrochemical microscopy
SGM, scanning gate microscopy
SHPM, scanning Hall probe microscopy
SICM,
scanning ion-conductance microscopy
SPSM
spin polarized scanning tunneling microscopy

SSRM,
scanning spreading resistance microscopy
SThM, scanning thermal microscopy
STM, scanning tunneling microscopy
STP, scanning tunneling potentiometry
SVM, scanning voltage microscopy
SXSTM,
synchrotron x-ray scanning tunneling mi

Block diagram of the SECM apparatus

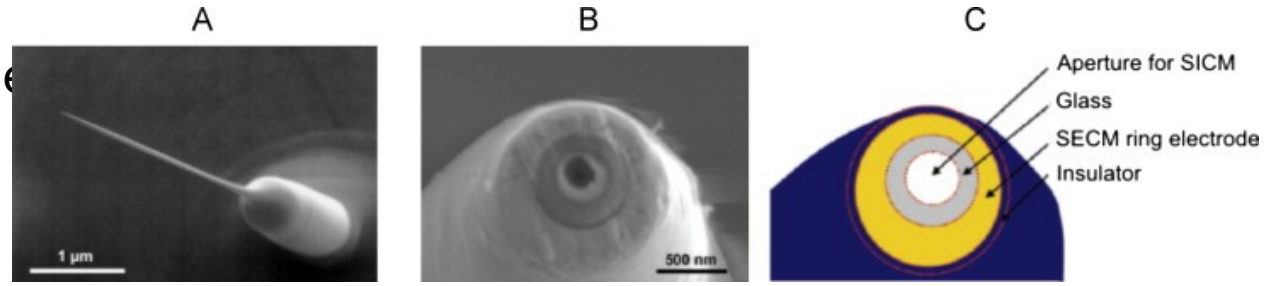


t is often mounted on a vibration-free optical table inside a Fara

ULTRAMICROELECTRODES: THE PROBE FOR SECM

Size: A few nm to 25 micrometers

Shape: Hemispheres, Cone
Disc

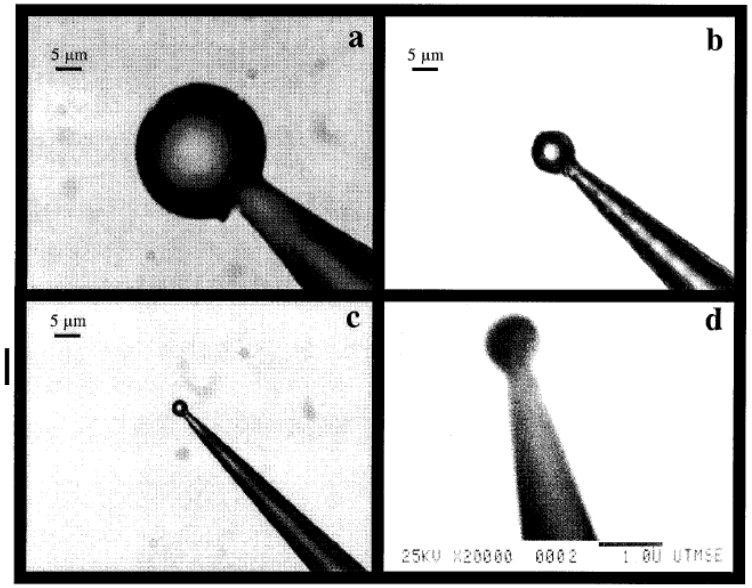


Materials:

Metal microelectrodes: Disc in glass microelectrodes
Submicrometer Glass Encapsulated
Microelectrodes
Electrochemical etching of metal wires

Self assembled spherical gold nanoparticles

Substrates:
glass, metal, polymer, biological material or l



Bard, A. J. *et al*. *Anal. Chem.* 1997, 69, 2

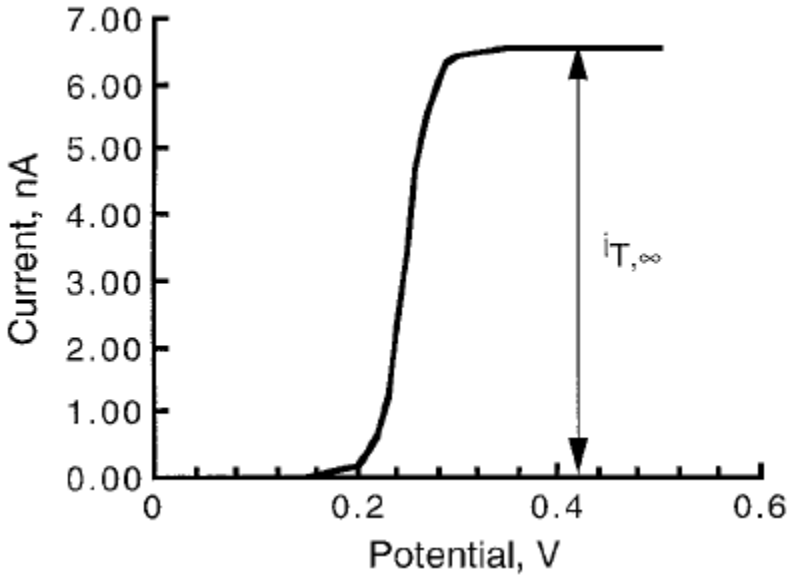
SECM: PRINCIPLE

iT = 4nFDca

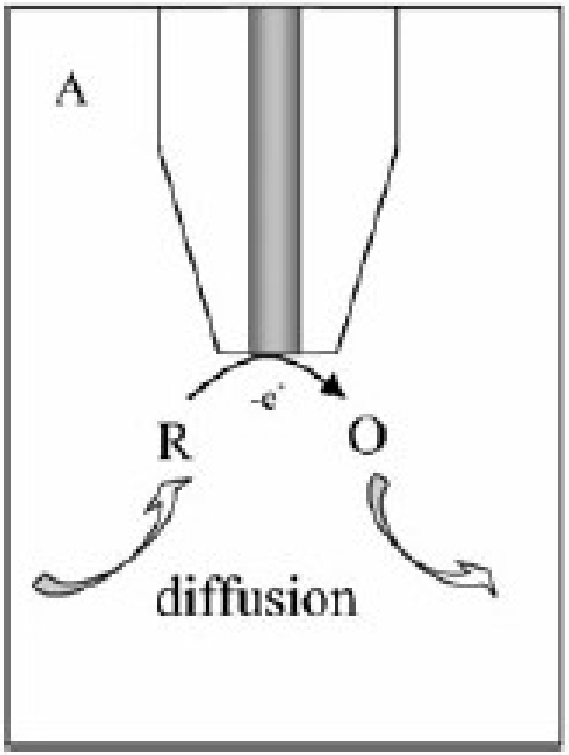
Measures the current through an UME when it is held or moved in a solution in the vicinity of a substrate.

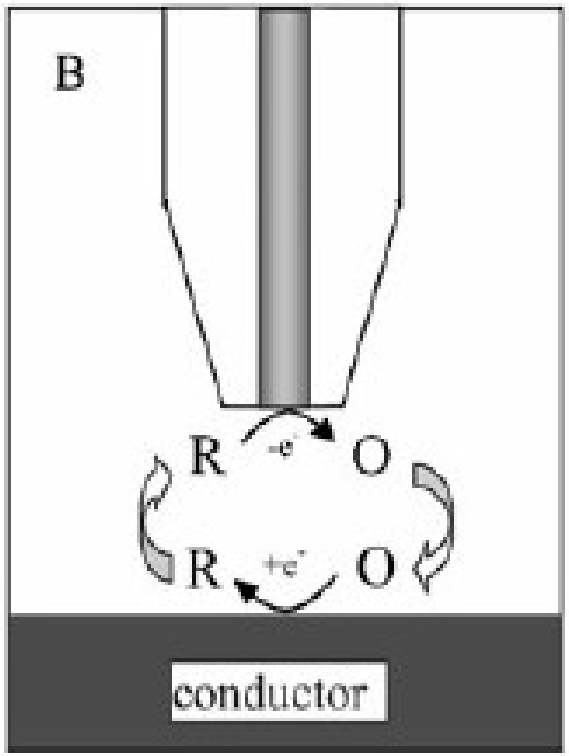
The presence of the substrate perturb the electrochemical response of the tip, and this perturbation provides information about the nature and properties of the substrate.

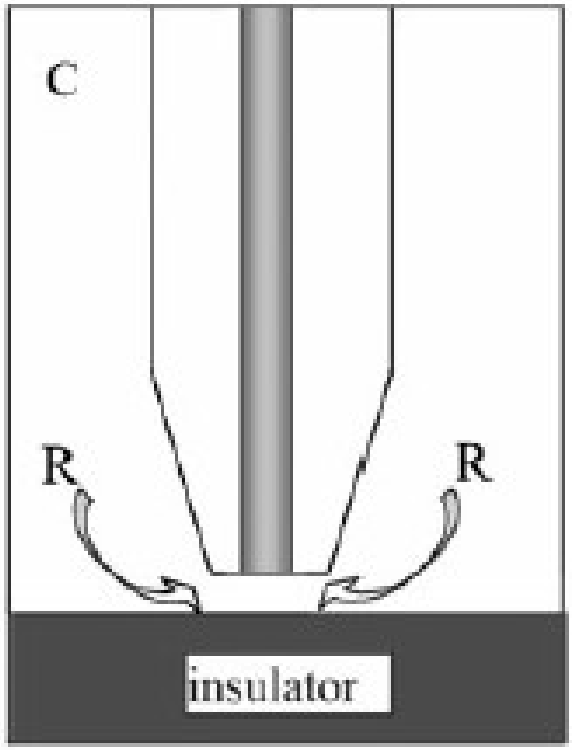
Because of the small currents that characterize most experiments with ultramicroelectrode tips, generally pA to nA, resistive drops in the solution during passage of current are generally negligible



FEED BACK MODE





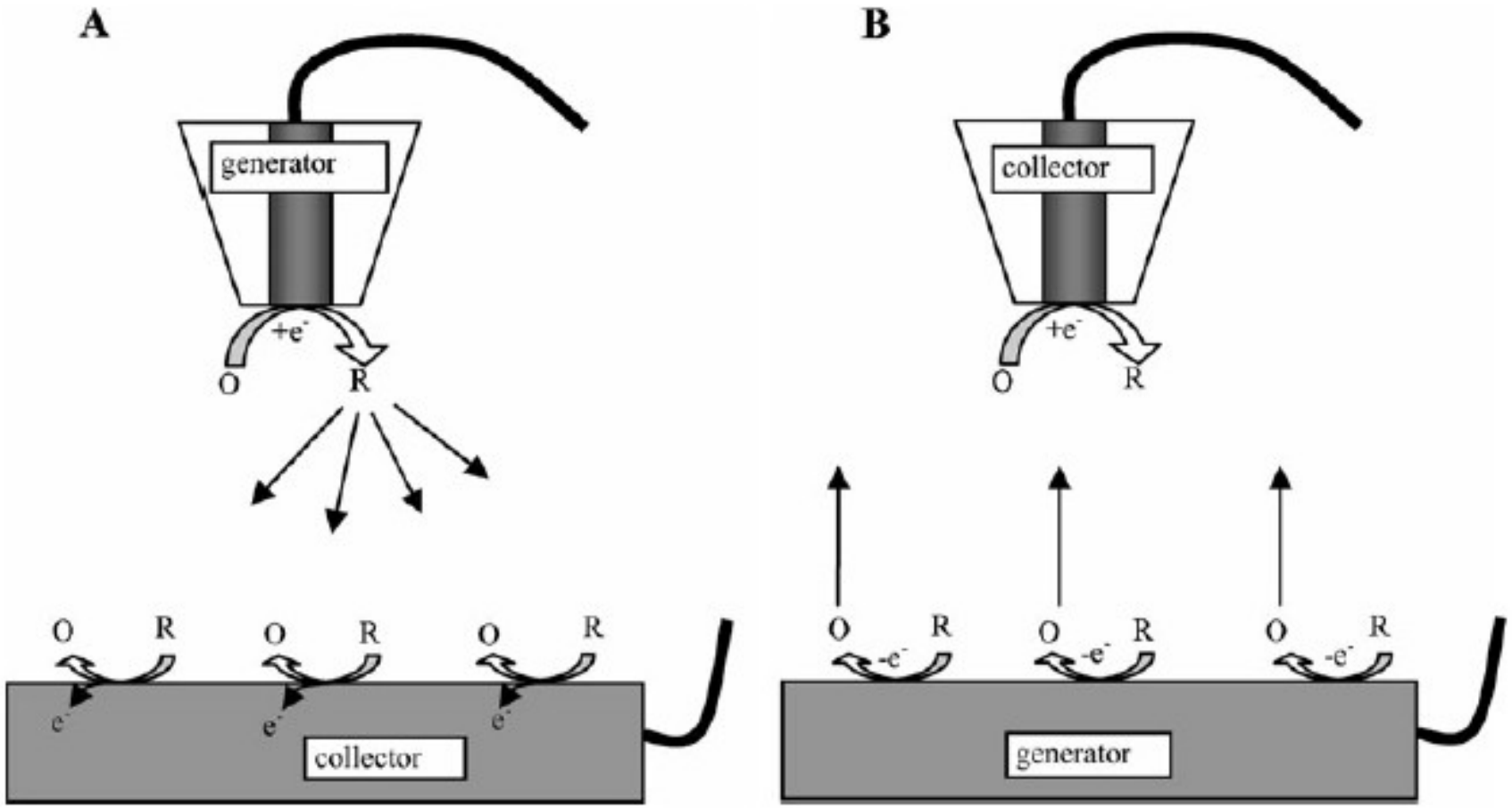


Tip far from substrate

Positive feedback

Negative feedback

COLLECTION-GENERATION MODES



Measures both tip and substrate currents

APPLICATIONS

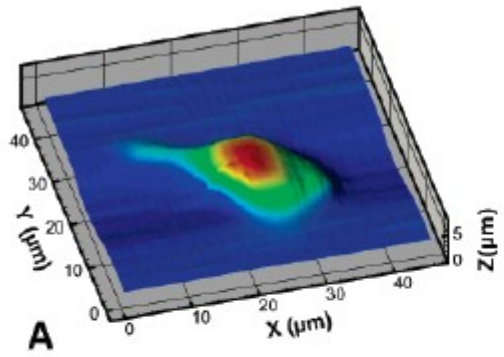
Heterogeneous reactions at solid-liquid interfaces:electron transfer kinetics, electroanalysis,

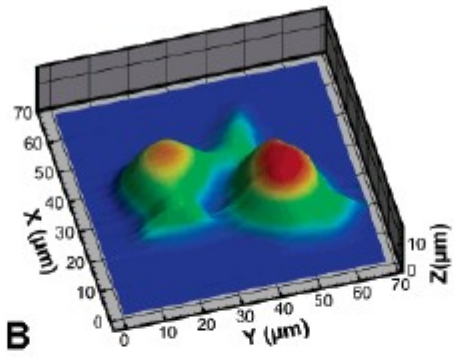
Surface patterning

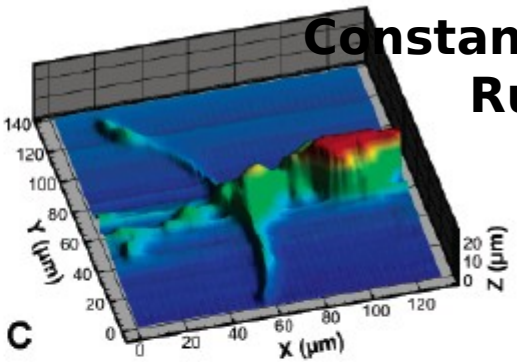
Biology: Cellular redox processes, Studies of redox enzymes, proteins, DNA, Membrane transport

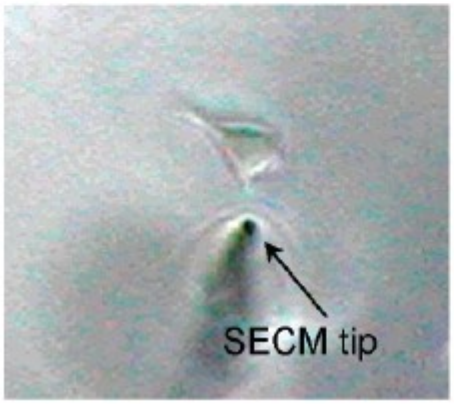
SECM imaging

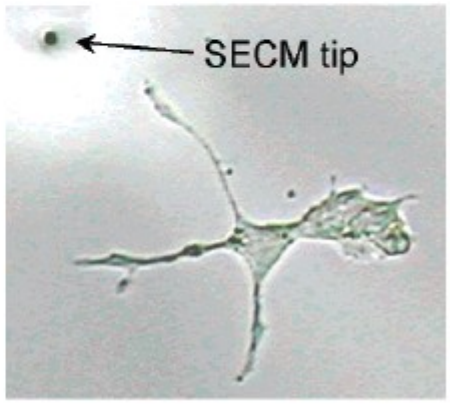
PC12 cell
Constant-current mo
Ru(NH3)63+





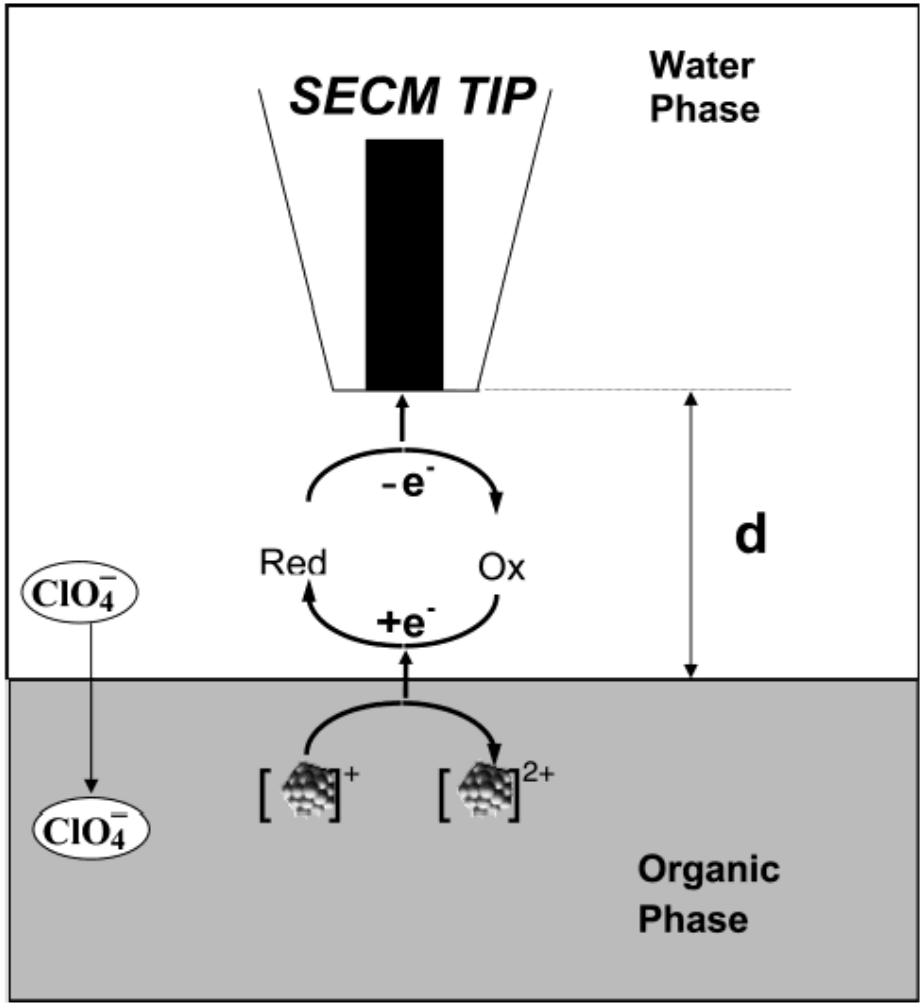


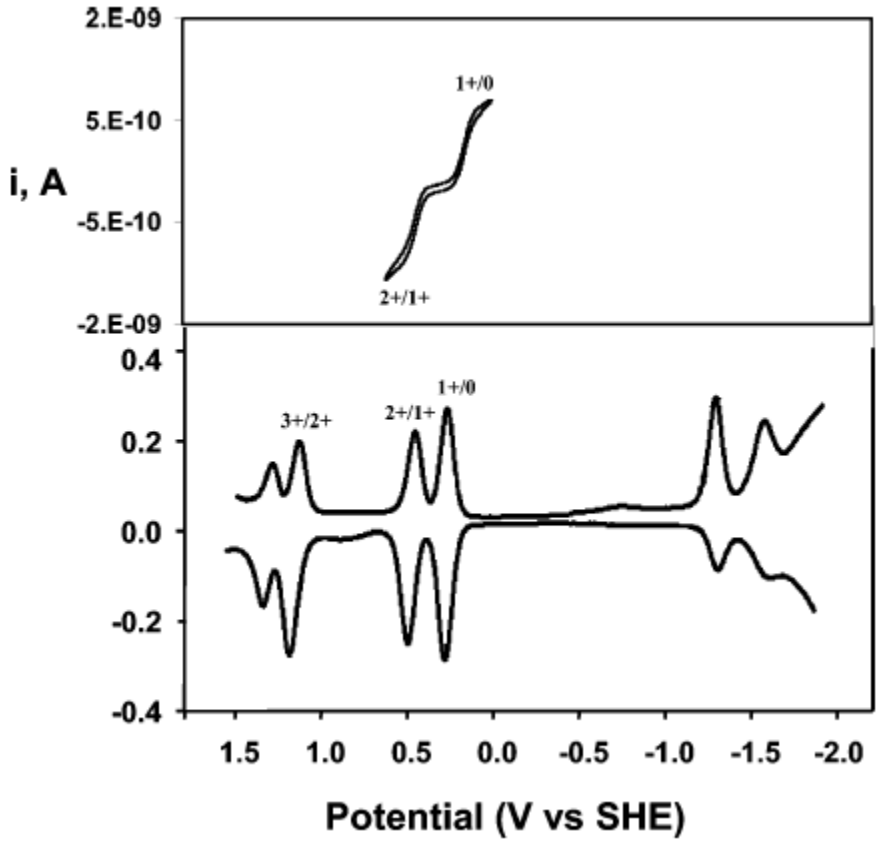




Baur, J. E. et al. *Anal. Chem.* **2005, 77, 1111**

SECM measurement of the fast electron transfer dynamics between Au381+ nanoparticles and aqueous redox species at a liquid/liquid interface





Murray, R. W. et al. *Nano Lett.* **2004, 4, 1763-1767**

THANK YOU