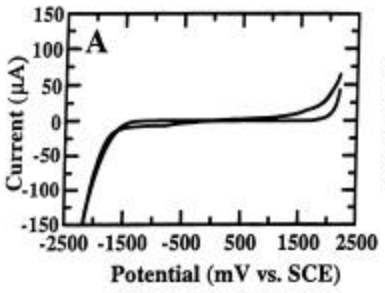
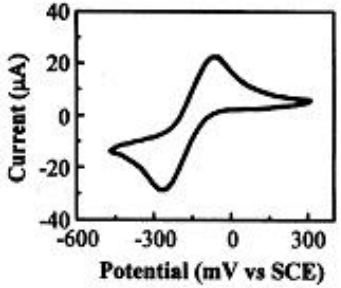
Electrochemical Properties of UNCD thin films

- Ultrananocrystalline diamond (UNCD) films doped with nitrogen are highly conductive and function as superb electrochemcial electrodes:
  - High overpotential for H_2 and O_2 evolution
  - Wide potential window (4 eV in aqueous soltuion desirable for inducing action potential in nerve tissue)
  - Low thickness (100 nm) for pinhole free, conformal coatings on microtip arrays
- For reasons enumerated above , UNCD electrodes are an enabling technology for demanding biomedical and sensor applications.
- UNCD electrodes exhibit a wide working potential window, a low background current, and a high degree of electrochemical activity for redox systems such as $Fe(CN)_6^{-3/-4}$, $Ru(NH_3)_6^{+3/+2}$, $IrCl_6^{-2/-3}$, and methyl viologen ($MV^{+2/+}$).
- Heterogeneous electron transfer rate constants of 10^{-2} to 10^{-1} cm/s are observed at films without any pretreatment.
- Nerve stimulation via implanted retinal chip is the key issue to be resolved for artificial sight, and UNCD may offer solution to the electrode problem (Platinum electrodes do not work since redox reactions cause degradation.
- Advantages of UNCD as a bioelectrode:
  - Electrically conductive (via nitrogen-doping)
  - High overpotential for O_2, H_2 evolution
  - Resistant to corrosion
  - Biocompatibility

Cyclic Voltammetric I-E Curves

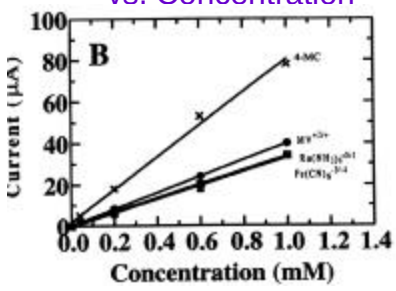


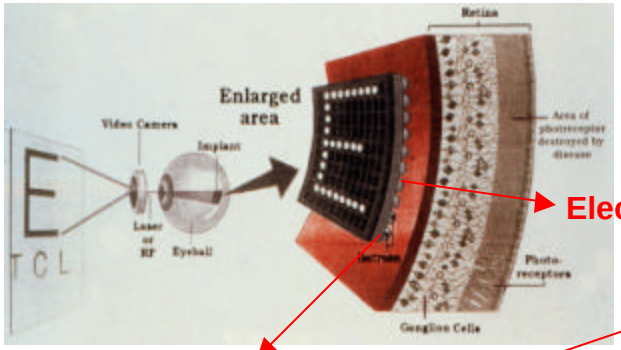
$HClO_4$



$Ru(NH_3)_6^{+3/+2}$

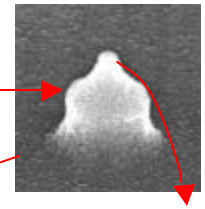
Peak Currents vs. Concentration



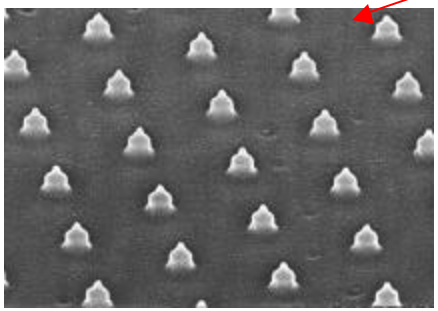


Artificial Retina Project
DOE Biomedical Engineering

Electrodes



Microelectrode Array



Conformal UNCD coating on Si microelectrode