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Electrochemical behavior of nanodiamond microprobe

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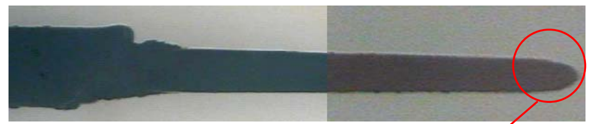
Abstract
Diamond has demonstrated very unique properties for electrochemical analysis[1-3]. Boron doped nanodiamond microprobes display reversible kinetics over a large potential window with low non-Faradic current and large signal to background ratio for redox systems without the need of surface pre-treatment. The structural stability at high potentials and current densities makes it stable for long term application. Its chemical inertness and corrosion resistance makes it suitable for use in harsh environments and *in vivo* conditions.

Boron doped nanodiamond microprobes (Figure 1) were fabricated with plasma enhanced chemical vapor deposition of nanodiamond on sharpened tungsten probes. Trimethylboron (TMB) was used as the source for boron doping. Nanodiamond coated tips with a diameter less than 240nm (Figure 2) and more than 98% diamond per Raman spectroscopy were obtained. Electrochemical analysis was performed using a single compartment, three electrode cell to detect $Fe(CN)_6^{-4}$ with KCl as background. The microprobes showed a higher sensitivity and enhanced detection limits with sharper tips and higher boron content. As the dimensions of the tip become smaller, spherical diffusion dominates planar diffusion at the active interface, rendering higher signal to background ratio. The tip size and conductivity were varied to fabricate microprobes with varying impedances. Longer probe size gave higher peak currents. A large stable potential window of 3V (Figure 3) and reversible kinetics were observed upon repeated analysis, as compared to plain tungsten probes which display a smaller potential window with quasireversible kinetics. The peak separation for oxidation-reduction peaks proves there is reversible electron transfer for the nanodiamond microprobe. A linear graph is obtained when oxidation peak current is plotted against the concentration of $Fe(CN)_6^{-4}$.

Figure 1. Optical micrograph of boron doped nanodiamond microprobe.



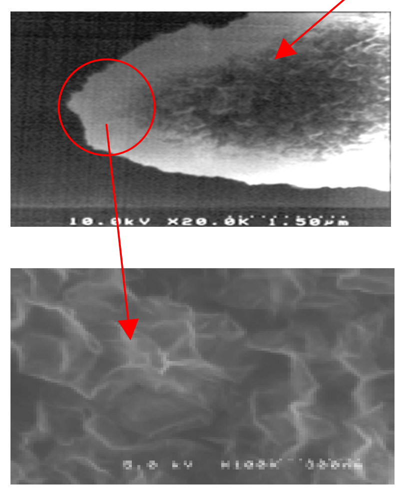


Figure 2. SEM micrograph of nanodiamond microprobe

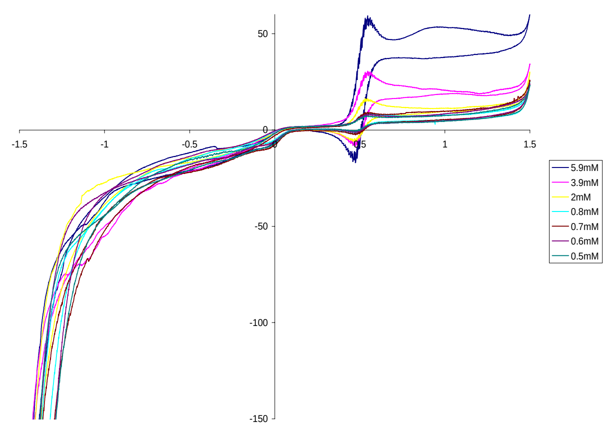


Figure 3. Cyclic Voltammogram of nano-diamond microprobe for detecting various concentrations of $Fe(CN)_6^{4-/3-}$ in 0.1 M KCl.

References
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