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SUPPORTING INFORMATION FOR

An Intercalator Film as a DNA-Electrode Interface

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Materials

EtX and thiol-modified PCR product were obtained from GenoRx (Hayward, CA). DNA synthesis reagents were purchased from Glen Research (Sterling, VA). Methylene Blue (MB) and potassium ferrocyanide were purchased from Sigma. Au on Si substrates (for SEM imaging) were purchased from Platypus technologies (Madison, WI).

Oligonucleotide synthesis

DNA synthesis was performed using standard solid-phase techniques. Thiol-modified oligonucleotides were prepared and purified by reverse phase (HPLC) as previously reported.[1]
The 15-base-pair DNA sequences for nanoparticle labeling assays were as follows:
Thiol-modified DNA probe: $^{5'}$(HS)-GATAGTCATCATCAA$^{3'}$
Complementary target: $^{5'}$TTGATGATGACTATC$^{3'}$
The 30-base-pair DNA sequences for the generation of C6 alkanethiol-tethered DNA films were as follows:
Thiol-modified DNA probe: $^{5'}$(HS)-TAAAGGTCCACGGGGTCTTTCCGTCTTGCC$^{3'}$
Complementary target: $^{5'}$GGCAAGACGGAAAGACCCCGTGGACCTTTA$^{3'}$

Thiol-modified and unmodified duplex DNA was prepared by adding equimolar amounts of complementary strands and annealing in deoxygenated 25 mM sodium phosphate/25 mM NaCl (pH 7) buffer by heating to 90˚C and cooling slowly to room temperature.

PCR amplification

PCR amplification and purification were performed as previously reported.[2] The sequence used for electrochemistry studies described in the supplementary information was:

5'ATCAAAGGAGTCATCATGGCACACCATGAAGAACAGCACGGCGGTCATCACCACCATCACC ACCACACACACCACCACCACTATCACGGCGGTGAACACCACCATCACCACCACAGCTCTCA TCATGAAGAAGGTTGTTGCAGCACTAGCGATAGTCATCATCATCAAGAAGAGGGTTGCTGCC ACGGGCATCACGAGTAATATCGGTGTGGCTAGGGGCAACTT3' (225 nucleotides).

Nanoparticle-DNA attachment

Thiol-modified single-stranded and double-stranded DNA and thiol-modified PCR product labeled with 5 nm Au nanoparticles were prepared following established protocols.[3] Nanoparticles (Ted Pella), were stabilized using bis(*p*-sulfonatophenyl) phenylphosphine dihydrate dipotassium salt (Strem Chemicals). After stabilization, nanoparticles were precipitated from solution by adding solid sodium chloride until a blue color change was observed. The nanoparticles were then pelleted and resuspended in a smaller volume to produce a concentration of ~ 450 nM. Gold nanoparticle-DNA conjugates were formed by incubating molar equivalents of thiol-modified DNA and nanoparticles in 25 mM sodium phosphate/25 mM sodium chloride (pH 7) buffer solution. Typical incubation periods ranged from 8 to 16 hours. Successful linking was verified by gel electrophoresis as described.[3]

Preparation of EtX films

EtX films were prepared by dispersing EtX onto surfaces (Au electrodes or Au surfaces) in approximately 10 uM concentrations in aqueous solution. EtX was allowed to deposit on surfaces or electrodes for 1 hour at room temperature in a humidity chamber.

Observation of DNA binding to EtX films with SEM

SEM imaging was performed with a JEOL 6340F Scanning Electron Microscope. Gold on silicon substrates were incubated with EtX as described earlier. Nanoparticle-labeled DNA conjugates were incubated at room temperature with EtX modified films in 25 mM sodium phosphate/25 mM NaCl (pH 7) buffer solution for 1 hour in a humidity chamber. After DNA

incubation, Au surfaces were rinsed with 25 mM sodium phosphate/25 mM NaCl (pH 7) buffer solution followed by rinses with water and then allowed to dry before imaging.

Electrochemistry

All cyclic voltammetry measurements were performed on a Bioanalytical Systems CV-50W potentiostat in an aerated 25 mM sodium phosphate/25 mM NaCl (pH 7) buffer solution. The experiments were conducted at room temperature using a standard three-electrode configuration consisting of a modified gold working electrode (area = $0.02cm^2$), a Pt wire as the counter electrode, an Ag/AgCl reference electrode. IR compensation was employed for all cyclic voltammetry measurements with scan rates of 10 V/s and above. Ferrocyanide studies were performed in 1 mM $Fe(CN)_6^{4-}$. Methylene Blue (MB) studies were performed in the presence of 1 uM MB. In the case of PCR DNA. stronger MB redox signals were observed when MB, EtX, and the PCR were preincubated for 30 minutes followed by deposition on the Au electrode for 1 hour at room temperature in a humidity chamber. Pre-incubation of PCR DNA was performed to insure that EtX would not occupy all the binding sites. Incubation ratios were 1:1:10 (EtX:MB:nucleotides) in 25 mM sodium phosphate/25 mM NaCl (pH 7) buffer solution. Alkane-thiol tethered duplex DNA films were prepared by incubating Au electrodes with SH-dsDNA in 25 mM sodium phosphate/25 mM NaCl (pH 7) buffer solution for 1 hour.

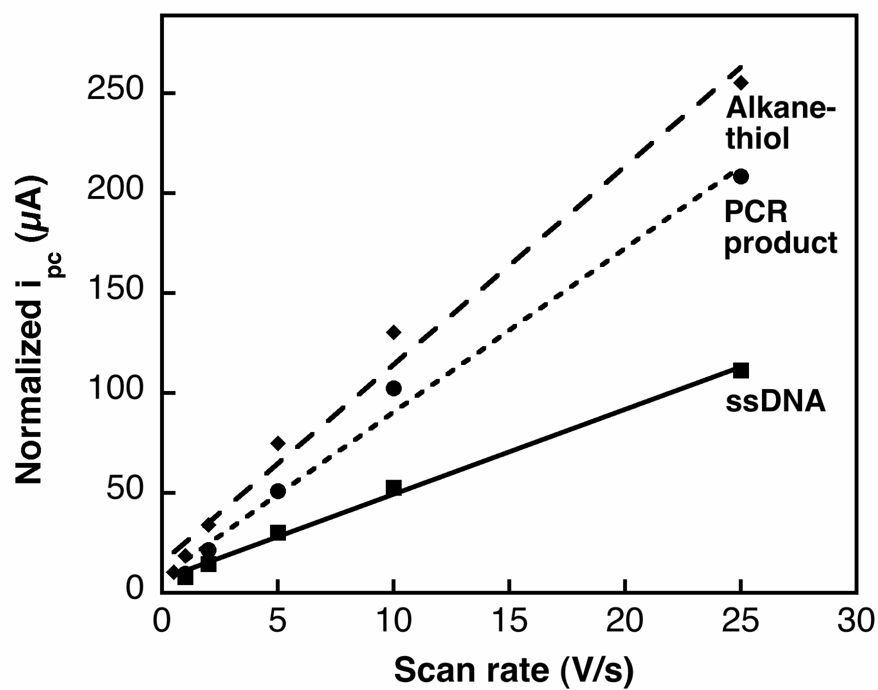

Figure S1: Cyclic voltammetry scan rate analysis showing that MB is surface bound in the presence of PCR DNA and 30-base ss DNA on EtX films, and in the presence of 30-bp alkane-thiol tethered dsDNA mololayers. Currents due to surface bound species scale linearly with scan rate, while currents from solution-borne species increase linearly with the square root of the scan rate.

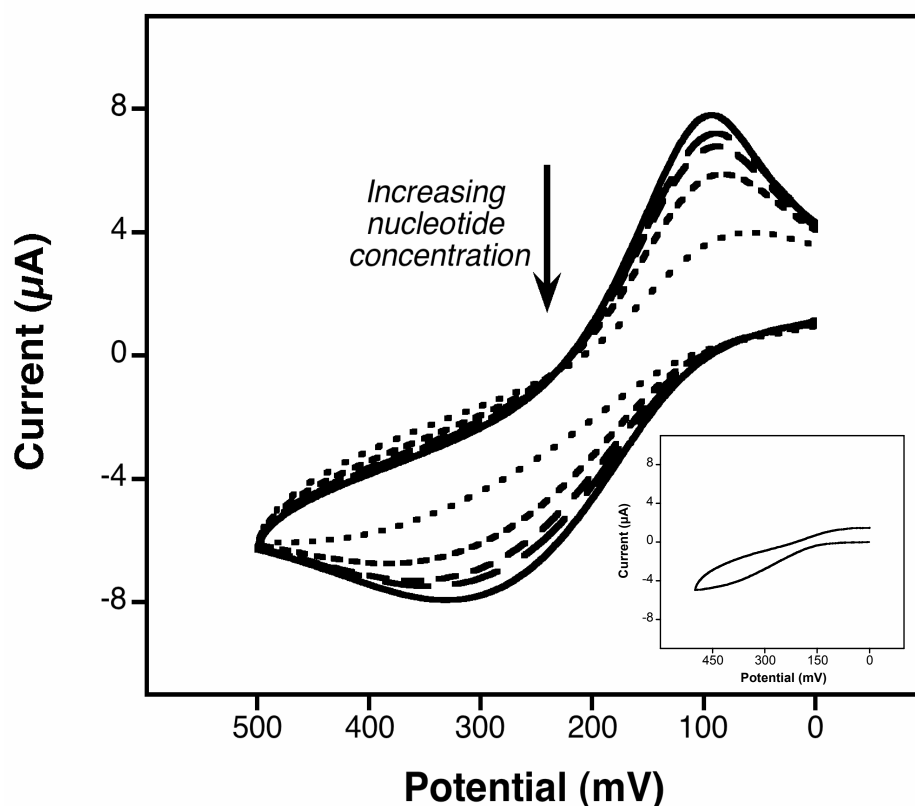

Figure S2: Titration of PCR DNA on an electrode supporting an EtX film (solid line represents after EtX monolayer formation) and dashed/dotted lines represent increasing concentrations of PCR DNA (0.1 μM nucleotides to 100 μM nucleotides). The adsorption of DNA to the EtX modified electrode resulted in a decrease in oxidation of negatively charged ferrocyanide due to the electrostatic interactions with the DNA backbone. Surface coverage of PCR DNA on an EtX film is comparable to an alkanethiol tethered 30-base-pair dsDNA monolayer (inset).

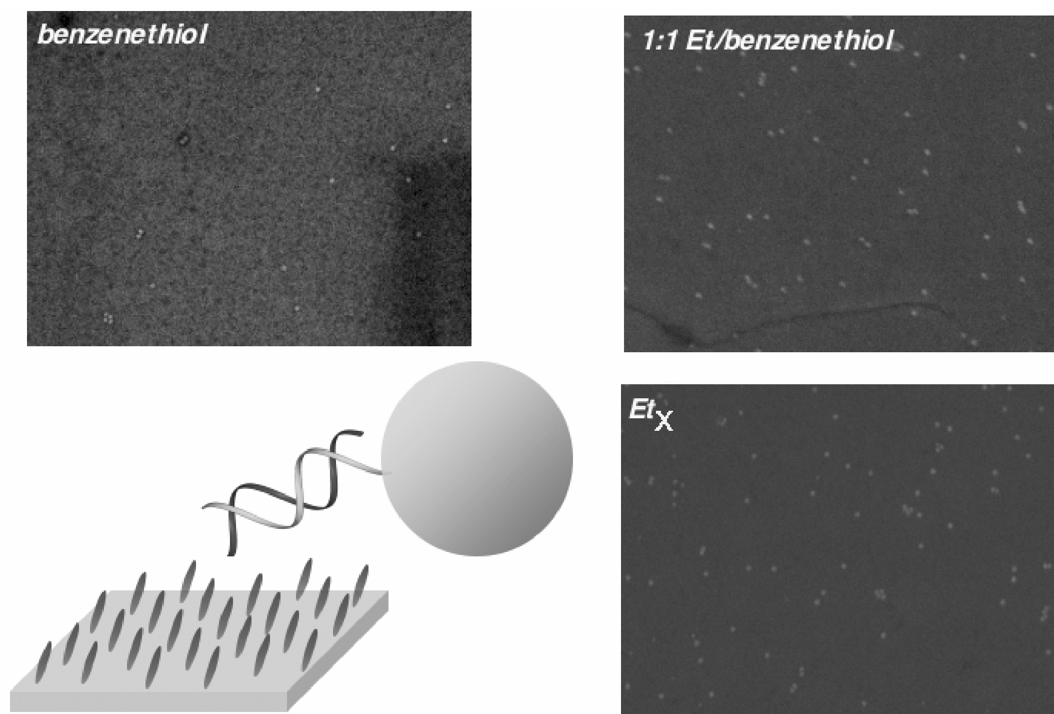

Figure S3: Effect of a diluent on EtX films' DNA binding properties. Benzenethiol shows little DNA binding where an equal ratio of EtX and Benzenethiol and an EtX only monolayer both show DNA binding, with more binding to the 100% EtX film.

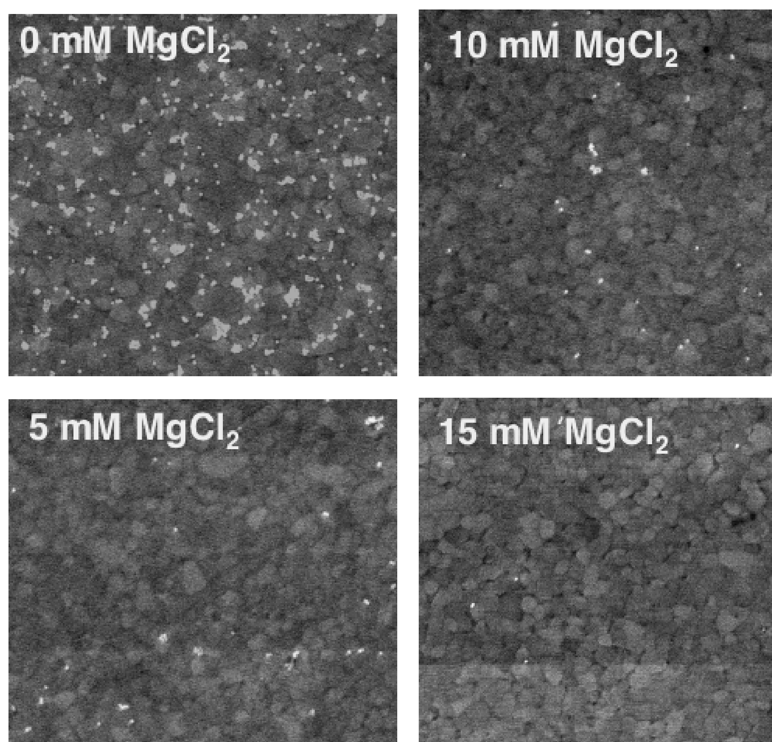

Figure S4: Effect of high ionic strength washing of EtX films with nanoparticle-labeled DNA bound. The remaining amount of bound DNA decreases as the ionic strength of the washing buffer increases, showing the importance of electrostatics in the binding of DNA to EtX films.

Supporting References:

S1 Taft, B. J.; O'Keefe, M. O.; Fourkas, J. T.; Kelley, S. O. *Anal. Chim. Acta* **2003**, *496*, 81-91.
S2 Lapierre, M. A.; O'Keefe, M. O.; Taft, B. J.; Kelley, S. O. *Anal. Chem.* **2003**, *75*, 6327-6333.
S3 Loweth, C. J.; Caldwell, W. B.; Peng, X.; Alivisatos, A. P.; Schultz, P. G. *Angew. Chem. Int. Ed.* **1999**, *38*, 1808-1812.