Conductivity of a Single DNA Duplex Bridging a Carbon Nanotube Gap

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Supporting Information

1. Structures and Syntheses of DNA molecules.

Oligonucleotide Synthesis.

Umodified oligonucleotides were prepared using standard phosphoramidite chemistry on an Applied Biosystems 394 DNA synthesizer, purified by HPLC and characterized by mass spectrometry. Two strategies were used to synthesize DNA modified with only a single amine at the 5′ terminus and DNA modified with amines at both the 3′ and 5′ termini. Oligonucleotides modified with an amine on the 5′ terminus only were prepared via solid phase synthesis on a CPG resin with an unprotected hydroxyl group at the 5′ terminus. The 5′-OH was treated with a 120 mg/mL solution of carbonyldiimidazole in dioxane for two hours followed by an 80 mg/mL solution of 1,3-diaminopropane. The beads were thoroughly washed with dioxane, acetonitrile, and methanol leaving a free amine at the 5′ end. Oligonucleotides modified with amines on both the 3′ and 5′ termini were prepared via solid phase synthesis using reagents purchased from Glen Research, Inc. The solid phase synthesis was performed on 3′-PT-Amino-Modifier C3 CPG with the 5′-Amino-Modifier C3-TFA phosphoramidite added in the final step of the solid phase synthesis to leave protected amines at both the 3′ and 5′ ends. In all instances, the oligonucleotides were cleaved from the resin with concentrated ammonium hydroxide before being stringently purified by HPLC with a C18 column. The purified oligonucleotides were quantified via UV-Visible spectroscopy. Complementary single strand DNA was hybridized with its complement by heating equimolar amounts of each strand in buffer containing 5 mM

phosphate, pH = 7.1, 50 mM NaCl to 90 ºC, followed by cooling to ambient temperature.

2. Reaction conditions for reconnection and subsequent chemistries.

Reconnection conditions:

Carboxylic acid activation: Newly-cut devices were incubated overnight in the BupH™ MES buffered Saline solution (pH 4.7, Pierce Biotech.) containing 5 mM EDCI and 10 mM Sulfo-NHS. The devices were then removed from the solution, washed with fresh buffer solution, and dried with a stream of Nitrogen gas for device characterization.

Amide formation: The as-formed devices were incubated in the BupH™ Phosphate Buffered Saline solution (pH 7.2, Pierce Biotech.) containing 10 uM duplex or single stranded DNA. The devices were then removed from the solution, washed with fresh buffer solution, and dried with a stream of Nitrogen gas for device characterization.

Dehybridization/hybridization conditions: The reconnected devices were immersed in a 50% formamide/DI water solution at 30 ^{0}C for one hour. Then the devices were removed from the solution, washed with DI water, and dried with a stream of Nitrogen gas. Subsequently, the above devices were incubated in BupH™ Phosphate Buffered Saline solution containing 10 uM of the corresponding single-stranded DNA. After one hour, the devices were removed from the solution, washed with fresh buffer, and dried with a stream of Nitrogen gas for device characterization.

DNA cutting conditions: The devices rejoined with duplex DNA were incubated in NEBuffer solution (pH 7.4, *New England Biolabs Inc.*) containing 100 units of the enzyme *Alu* I (*New England Biolabs Inc.*) at 37 ^{0}C for 6 hours. Then the devices were removed from the solution, washed with fresh buffer, and dried with a stream of N_2 gas for device characterization.

3. **The I-V characteristics of control experiments**.

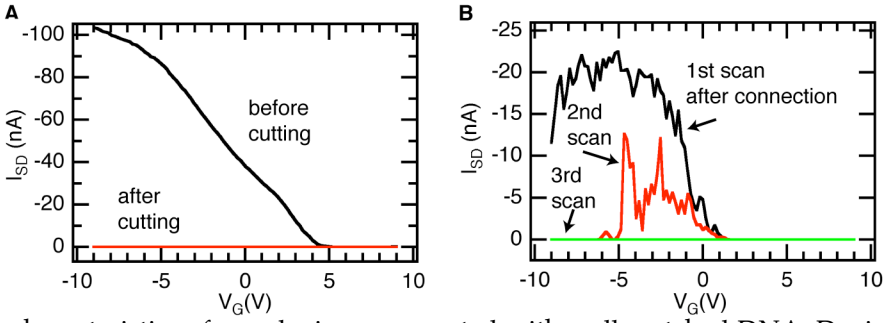

Figure S1. The characteristics of one device reconnected with well matched DNA. Device breakdown is observed when the gate voltage gradually increases, starting at ~ 6 V. V_{sd} = - 0.05 V. The sequence is the WM sequence from Figure 3 in the main text.

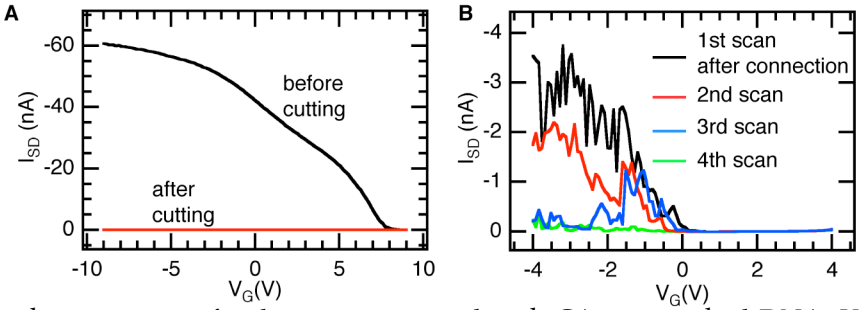

Figure S2. The characteristics of a device reconnected with CA mismatched DNA. V_{sd} = - 0.05 V. The sequence is the CA sequence from Figure 3 in the main text.

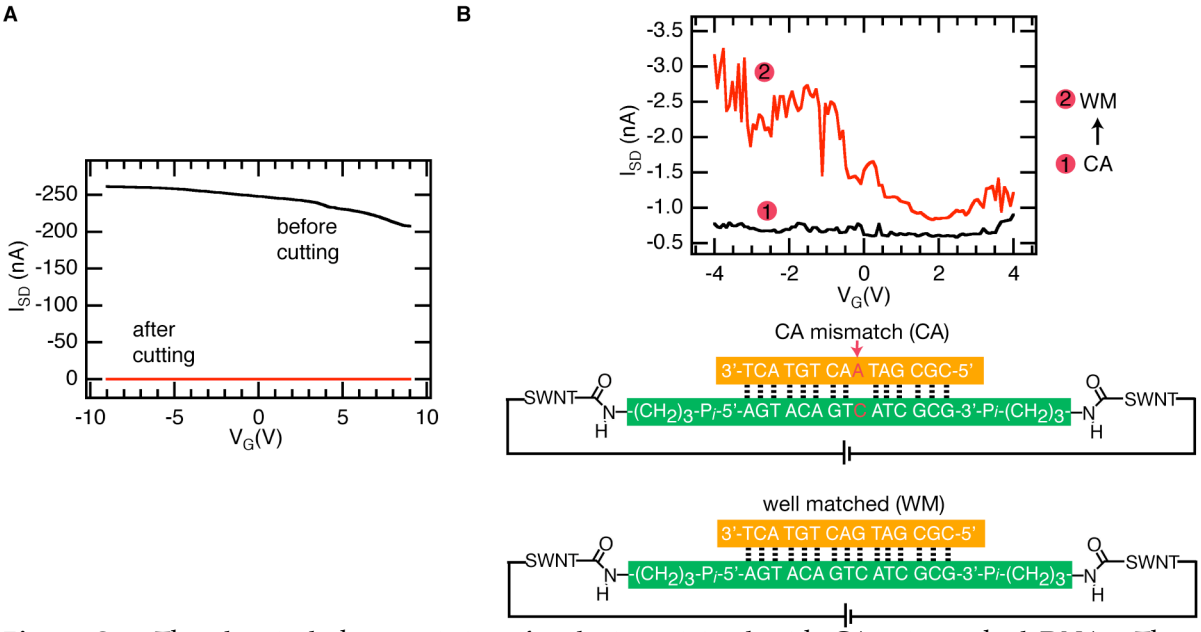

Figure S3. The electrical characteristics of a device rejoined with CA mismatched DNA. The steps involve cutting, reconnection and sequence exchange to well matched DNA. V_{sd} = - 0.05 V.

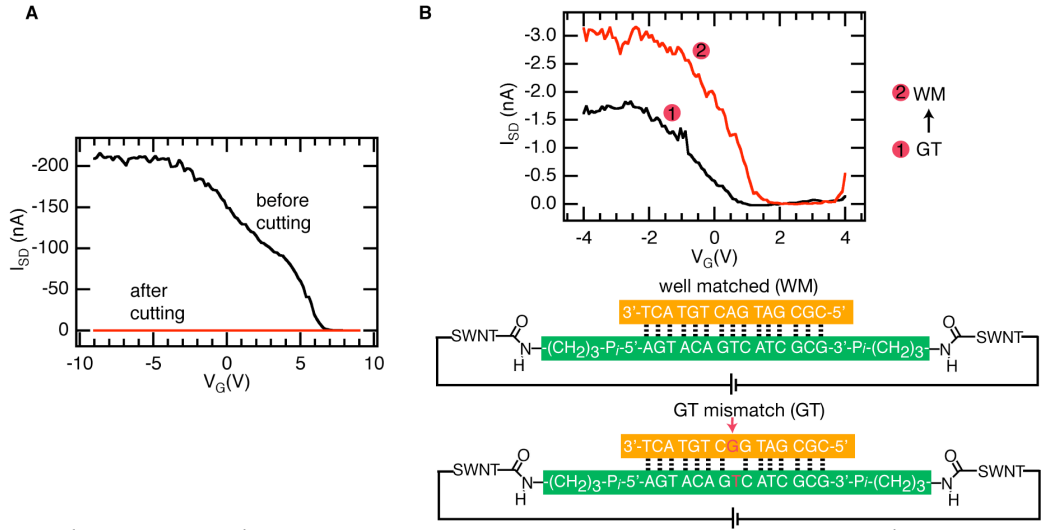

Figure S4. The electrical characteristics of one rejoined device by GT mismatched DNA. The steps involve cutting, reconnection and sequence exchange to well matched DNA. V_{sd} = - 0.05 V.

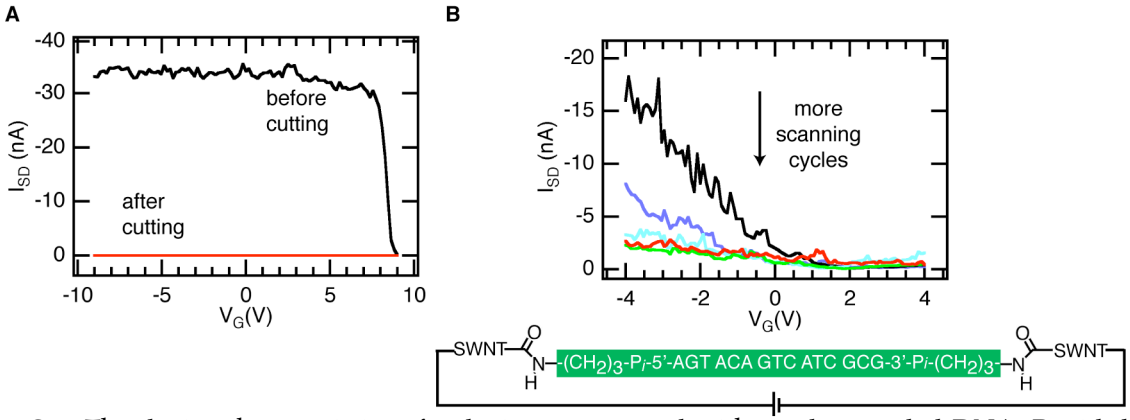

Figure S5. The device characteristics of a device reconnected with single-stranded DNA. Rapid device decay is observed after several cycles. V_{sd} = - 0.05 V.

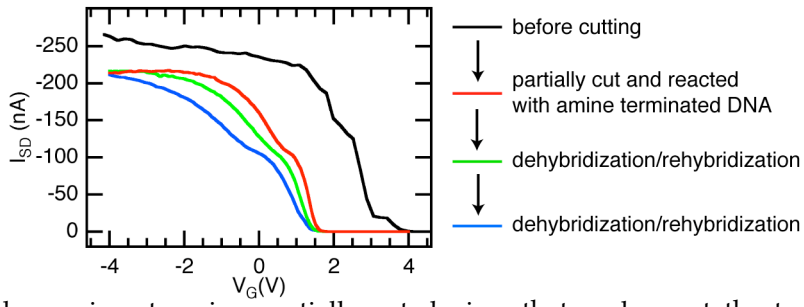

Figure S6: Control experiments using partially cut devices that underwent the treatment of cutting, reconnection, dehybridization, and rehybridization. None of the devices displayed any obvious changes in resistance or threshold voltage for each step of the procedure. V_{sd} = - 0.05 V. This is the same sequence of steps that are involved in steps 1, 2, and 3 in Figure 3.

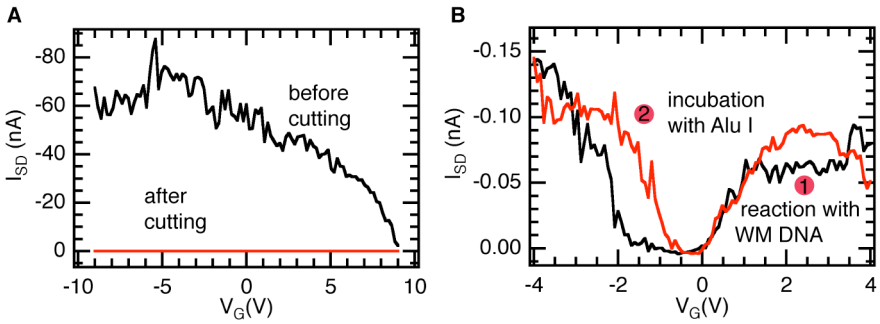

Figure S7. The electrical characteristics of one device rejoined with well matched DNA missing the Alu I restriction site showing the sequence of cutting, reconnection and treatment by Alu I. V_{sd} = - 0.05 V. The DNA sequence is the WM sequence from Figure 3 in the main text.