

Integration of Biomolecular Electronic Devices and Sensors

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- Integrating Single Molecules with Electronics
- Creating Functional DNA-Based Electronic Devices

Single-Molecule Integration?



Self-Aligning Single-Molecule Junctions





Single-Stranded DNA



Swager et al. *JACS p. 14009*, 2010



Self-Aligning Single-Molecule Junctions





Single-Molecule Devices?





SWCNT-DNA-SWCNT Devices





















Hopping Dominated Transport Behavior?



Modeling by M.P. Anantram's Group UW and Emre Oren, TOBB University



- Integrating Single Molecules with Electronics
- Creating Functional DNA-Based Electronic Devices

COVID: Rise of the Variants



Can we electrically identify variants?

D614G

wuhan- hu-1 Delta variant-Iraq Omicron variant-Iraq	v	A	v	L	Y	Q	D G G	V	N	с	т :	E	v	P	v	A	1	н	A	D	Q	L I	т :	P	т	w	R	v	Y	s	т	638	
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wuhan- hu-1 Delta variant-Iraq Omicron variant-Iraq	D	L	ו	с	A	Q	к	F	N K	G	L	т :	v	L	P	P	L :	L	т :	D	E	м	1	A	Q	Y	т :	s	A	L	L	878	

614D 5'-TATCAGGATGTTAACTGC-3' Wild Type

614G 5'-TATCAGGGTGTTAACTGC-3' Variant



Active Single-Molecule Electronics: Biosensing 614G Probe **mCN**⁻ $(CH_2)_6$ -ATAGTCCCACAATTGACG**mCNT** (CH₂)₆ CO CO TATCAGGGTGTTAACTGC 614G Target (D614G Variant) 614D Mismatch (Wild Type) TATCAGGATGTTAACTGC 10⁻⁴ Phase 1 Phase 3 Phase 4 Phase 5 Phase 2 Phase 6 Phase 7 Phase 8 Conductance (G₀) 10⁻⁵ No Junction 10⁻⁶ -100s Solution: Reformation Reformed Probe + Solution: 10⁻⁷ 20 µM 20 µM 614G 614D 614G 10⁻⁸ **Mismatch** Target 10⁻⁹ 20°C 20°C 65°C 65° **10**⁻¹⁰ 10⁻⁴ Phase 1 Phase 3 Phase 4 Phase 5 Phase 6 Phase 7 Phase 2 Phase 8 Conductance (G⁰) ⁶⁻01 (G⁰) ⁸⁻01 (C¹) Solution: No 10⁻⁶ -100s 20 µM Solution: Junction Reformation Probe + 614G 20 µM Reformed 614G Target 614D **Mismatch** 20°C 65[°]C 20°C **10**⁻¹⁰ Time (s)



Single-Molecule Biosensing



Electrically Controllable DNA-Based Electronics



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