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Predictive Model for Label-free Electrical Detection of Biomolecules PRADEEP NAIR, MUHAMMAD ALAM, School of Electrical and Computer Engineering, Purdue University — Biosensors based on MOSFETs, silicon nanowires, and carbon nanotube nanocomposites *promise* highly sensitive, dynamic, label-free, electrical detection of bio-molecules with potential applications in genomics and proteomics. Although tremendous improvements in sensitivity have been reported in electrical detection of bio-molecules, many aspects of experimentally observed sensor response (S) are unexplained within the theoretical frameworks of kinetic response or electrolyte screening. In this paper, we combine analytic solutions of Poisson-Boltzmann and reaction-diffusion equations to show that the electrostatic screening within an ionic environment limits the response of nanobiosensor such that $S(t) \sim c_1 \left(\ln(\rho_0) - \frac{\ln(I_0)}{2} + \frac{\ln(t)}{D_F} + [pH] \right) + c_2$ where c_i are geometry-dependent constants, ρ_0 is the concentration of target molecules, I_0 the salt concentration, and D_F the fractal dimension of sensor surface. Our analysis provides a coherent theoretical interpretation of wide variety of puzzling experimental data that have so far defied intuitive explanation and have important implications for the design and optimization of nanoscale biosensors.

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