Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Active Control of Protein and Ionic Transport through Semiconducting Conical Nanopores TEENA JAMES, YEVGENIY KALININ, CHIH-CHIEH CHAN, JATINDER RANDHAWA, Johns Hopkins University, MIKHAIL GAEVSKI, Princeton University, DAVID GRACIAS, Johns Hopkins University —
Nanopores with conical geometries have been found to rectify ionic current in electrolytes. While nanopores in semiconducting membranes offer the ability to modulate ionic transport, the fabrication of conical nanopores in silicon has proven challenging. Here, we report the discovery that Au nanoparticle-assisted plasma etching results in the formation of conical etch profiles in Si [1]. We show that this process provides a versatile means to fabricate nanopores on Si substrates with variable pore-diameters and cone-angles. When in contact with aqueous electrolyte solution (pH>3), the nanopore was found to exhibit negative surface charge due to de-protonation of the Si-OH surface groups. The rectification ratio of ionic current through the pore was thus found to be variable by altering the pH, owing to the amphoteric nature of Si-OH surface groups (pKa 6.9) and was also dependent on the ionic strengths, agreeing with the theoretical predictions based on Poisson−Nernst−Planck equation. We demonstrate that these semiconducting conical nanopores can function as ionic switches with high on-off ratios, by varying Si surface charge through voltage gating. Further, we demonstrate voltage gated control over protein translocation through these pores. [1]. Voltage-gated ion transport through semiconducting conical nanopores formed by metal nanoparticle assisted plasma etching, T. James, *et al.* Nano Letters 12, 7, 3437–3442 (2012).

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Date submitted: 26 Nov 2012 Electronic form version 1.4