OMICS Group Conferences
Accelerating Scientific Discovery

4th International Conference on

Nanotek & Expo

December 01-03, 2014 DoubleTree by Hilton Hotel San Francisco Airport, USA

Control and manipulation of a charged macromolecule in a nanosized gap between two fluid reservoirs

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Biomolecules and therefore living systems indispensably depend on the water environment for their survival and functioning. The ability of some biological assemblies like DNA or RNA polymerases to move along information-carrying polymers of nucleic acids with single nucleotide precision in water is vital for the machinery of life in order to replicate them correctly. Controlling the position of a macromolecule like DNA at single monomer accuracy is of great technological importance as well for developing high-speed electronic DNA sequencing devices. We use a simple born ion continuum model to analyze the effect of solvation energy change on the translocation of a charged linear polymer molecule through a nanosized vapor gap between two fluid reservoirs. As the effective radius of the discretely spaced charges increases, our model predicts a transition from trapping to the diffusion of the molecule in the vapor gap. We present results of creating such a nanogap achieved by a new experimental technique that uses an FPGA-driven nanopositioner, triggered by the entry of a DNA molecule at the constriction of the nanopipette. The developed platform will enable testing some of our recent theoretical predictions and has the potential for applications in biomolecular sensing.

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