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Controllable negative differential resistance on charge transport through DNA molecules YONG JOE, Ball State University — A double-stranded DNA molecule subject to a perpendicular gating electric field and a small mechanical strain exhibits a negative differential resistance (NDR) in its current-voltage (I-V) characteristics. Using an advanced two-dimensional tight-binding model including hopping integrals for the next nearest-neighbors, we implement perturbative strain- and tilted angle-dependent DNA helix conformation in conjunction with the theories of Slater-Koster and linear elasticity. The degree of NDR can be tuned by adjusting the tilt angle and mechanical strain of the DNA. This effect arises because of a surface charge distribution near the contacts due to the normal component of the electric field and structural change of the DNA molecule due to the strain. It is shown that enhancement of NDR peak current and a large peak-to-valley ratio of NDR are achieved by an increase of the tilt angle and stretching strain. Finally, a series of step-like current jumps without NDR features are exhibited in the weak DNA-lead coupling regime. This disappearance of NDR stems from the fact that reduced conduction through metal electrodes with a sufficiently small tunneling rate compensates the current drop.

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