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Graphene deflectometry for sensing molecular and ionic processes at the nanoscale

Single-molecule sensing is at the core of modern biophysics and nanoscale science, from revolutionizing healthcare through rapid, low-cost sequencing to understanding physical processes such as ionic hydration at their most basic level. However, rapid and/or weak interactions at the molecular scale are often too fast for the detection bandwidth or otherwise outside the detection sensitivity. Of critical importance, most of the envisioned biophysical applications are at room temperature, which further limits detection due to significant thermal noise. Here, we theoretically demonstrate reliable transduction of forces into electronic currents via locally suspended graphene nanoribbons, which allows for the detection of ultra-weak -- tens of picoNewtons -- and fast -- gigahertz -- processes, at room temperature. The sensitivity of electronic couplings to distance magnifies the effect of the deflection, giving rise to measurable electronic current changes even in aqueous solution. Due to thermal fluctuations, the characteristic charge carrier transmission peak follows the Voigt profile. Room temperature graphene deflectometry presents new opportunities in the sensing and detection of molecular-scale processes, from ion dynamics and DNA sequencing to protein folding, in their native environment.

References

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Figures

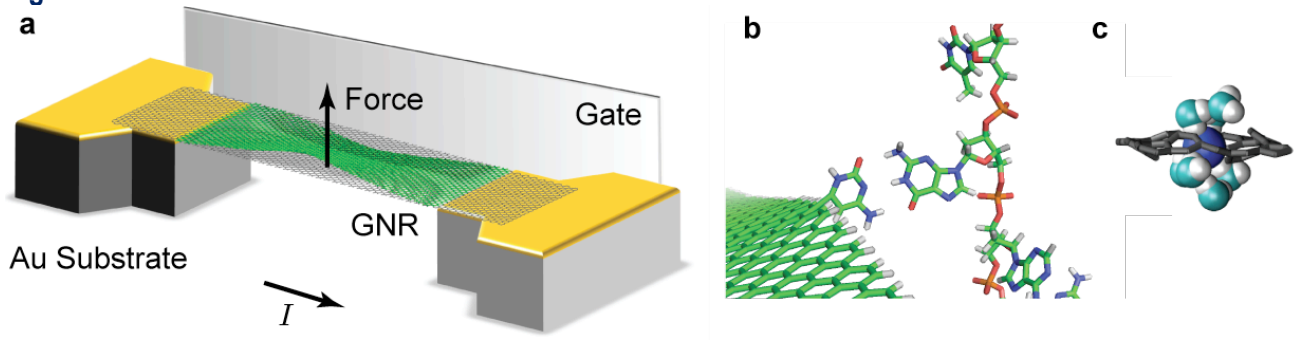

Figure 1: Graphene nanoribbon deflectometer. **a**. Schematic of a graphene ribbon suspended between two gold contacts in aqueous solution (omitted for clarity). Hydrated ions and molecules can deflect the graphene, e.g., **b**., by binding to a functional group at the ribbon edge or, **c**., by passing through a pore. The deformed ribbon is in green with an exaggerated upward deflection for visual clarity.