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DOCKING DNA AT THE EDGE OF GRAPHENE

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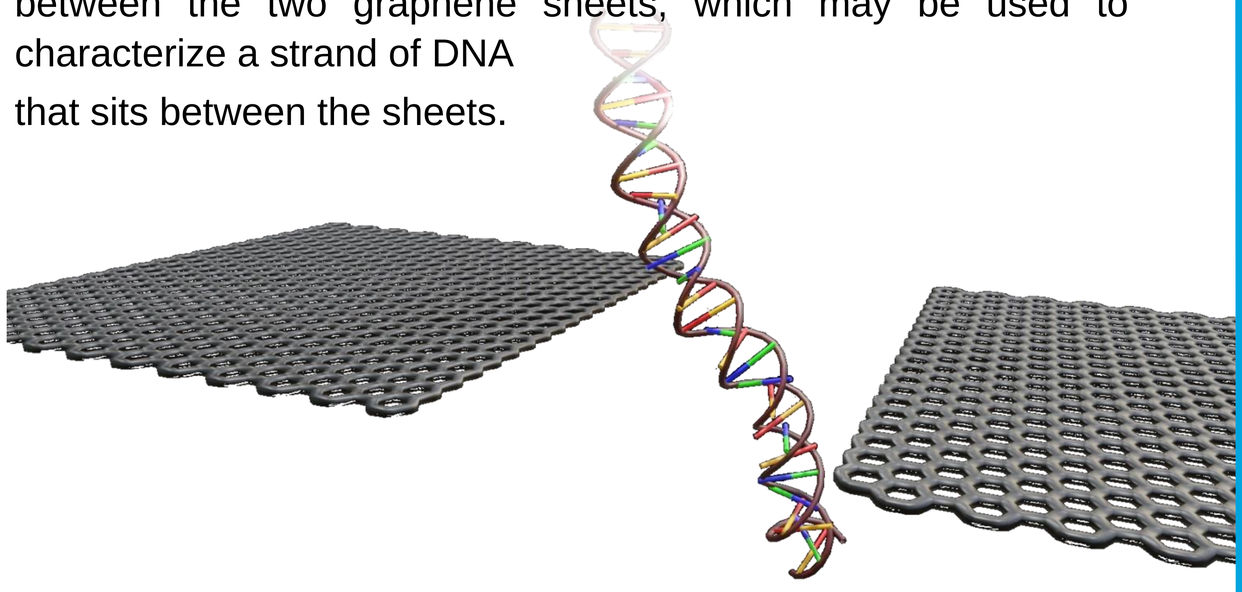
ABSTRACT

Devices that are aimed at using a tunnelling current to sequence DNA, with two graphene sheets lined up in a twisted configuration, cannot operate without a means to put the DNA strand at the graphene edge, where the tunnelling current is flowing. We aim to dock DNA and visualize the process at the same time, using a dual-action approach. We make use of two photochemical principles: on the one hand the so-called DNA light switch molecules, typically ruthenium complexes that light up when they bind to DNA, and on the other hand the fluorescence quenching effect of graphene, which is strongly dependent on the distance between the dye and the quenching species. By using both principles, we can design a platform that can dock DNA to a graphene edge through binding a ruthenium complex that is installed to the edge via a flexible linker, and show that the DNA is docked with fluorescence: as we can electrostatically change the distance between the edge and the ruthenium-DNA adduct, the fluorescence of this adduct will switch on and off, showing that the DNA is installed at the edge.

INTRODUCTION

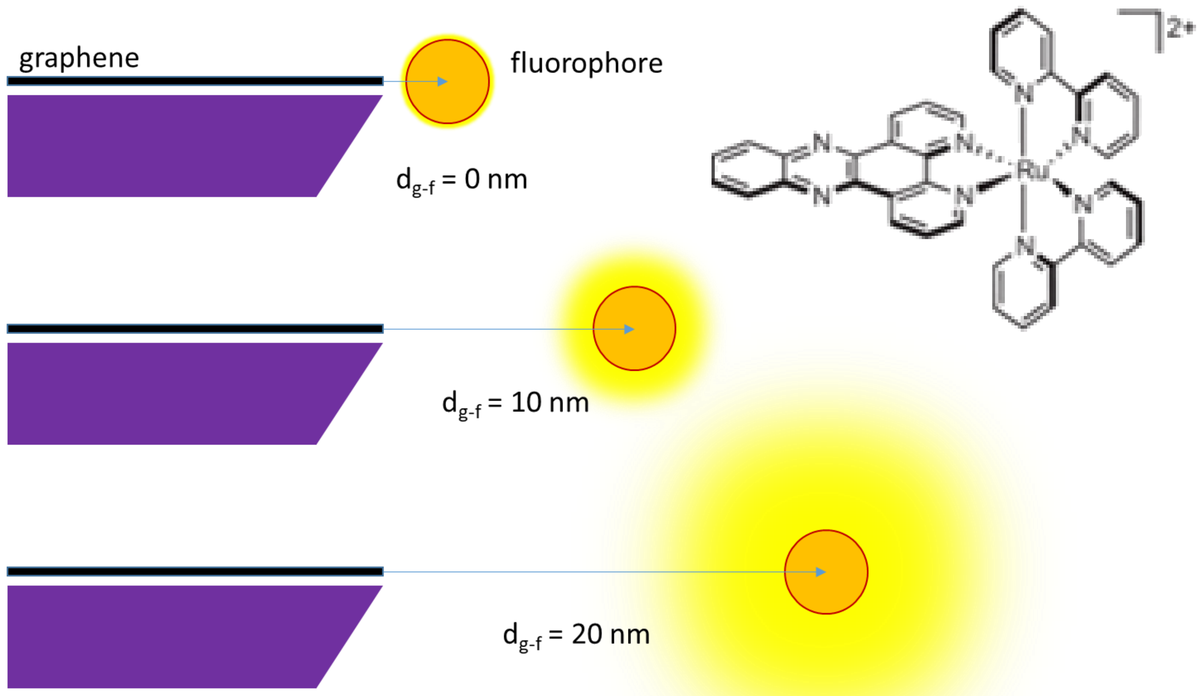
Electron tunneling devices were identified as a promising option to sequence DNA with a solid-state device. Such devices can be remarkably simple, for example if two sheets of graphene, a material that is only one atom thick, are placed opposite to one-other, they may be useful for DNA sequencing using electron tunneling.[1] Such a device enables a so-called “tunneling current” between the two graphene sheets, which may be used to characterize a strand of DNA that sits between the sheets.



FLUORESCENCE AS A DNA INDICATOR

A DNA light switch complex, $[Ru(bpy)_2(dppz)]^{2+}$, becomes fluorescent upon DNA binding, while it does not emit when no DNA is bound.[2] **Graphene quenches florescence however**, even from large distances (30 nm from the basal plane).[3] Yet, it may be lower for the graphene edge as quenching is orientation dependent.[4]

We aim to use the graphene edge and the Ru-DNA light-switch to show that the DNA is at the edge: through **single-molecule fluorescence measurements** the presence of DNA bound to the Ru-light switch can be shown.

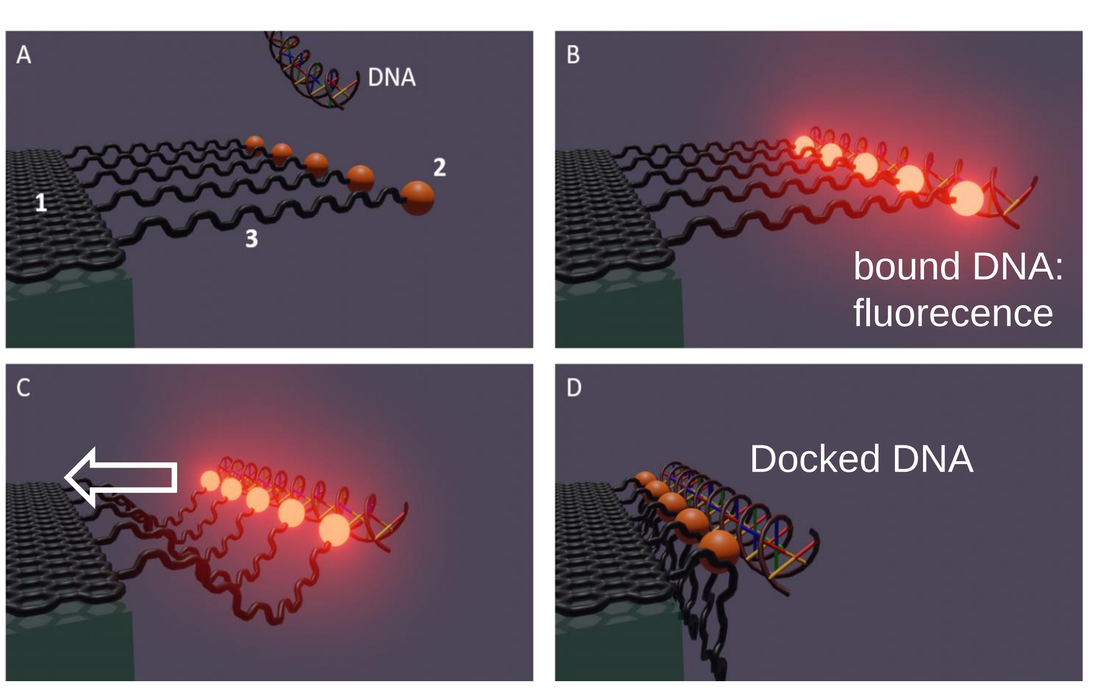


DARK-LIGHT SWITCHING SHOWS DNA DOCKING

When the Ru-light switch is bound to the edge, fluorescence will only occur in one particular case: when **DNA is bound** and it is **far away from the edge**. In other situations the fluorescence will be quenched:

- No DNA bound to Ru > no fluorescence
- DNA bound, but close to the edge > fluorescence quenched
- DNA bound, and away from the edge > **fluorescence**

By attaching the Ru complex via a flexible linker we allow distance control though electrostatic forces, and we can show DNA binding by **on-off behaviour of the fluorescence** when the electrostatic potential sign of graphene is altered. In this way, the **DNA is docked to the edge of graphene**.



CONTACT PERSON

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