DNA Translocation through Two Dimensional (2D) Nanopore

In a typical nanopore sensor setup, the nanopore is immersed in an electrolyte solution. When a voltage is applied across the nanopore, ions starts to flow through the pore. In that scenario, if any object translocate through the pore, there will be changes in the ionic current through the pore. One of the major applicabilities of nanopore sensor is DNA sequencing. Because of the differences in the size of the nucleotides, translocation of DNA through the nanopore results in different level of ionic current blockage based on which the DNA sequencing can be carried out. DNA sequencing has been achieved using protein nanopore such as α-hemolysin and MspA. However, these biological nanopores are highly sensitive to surrounding environment and they often suffer from low thermal and chemical stability. Consequently, solid state nanopore comes into picture.

Presently available solid state nanopores are mostly made up of silicon derivatives such as silicon nitride, silicon oxide and amorphous silicon pores. However, these nanopores suffer from low temporal and spatial resolutions. While measuring the ionic current, the DNA molecule also translocate at a high speed of $\approx 30 \times 10^6$ nt/s. However, the existing data acquisition systems are not adequate enough to process signal at this high frequency (i.e. ≈ 30 MHz).

However, in the recent years 2D nanopores shown great promises. Their atomically thin structure leads to lower electrical resistance of the nanopore which results in higher ionic current. Also, because of its thin structure, only a small portion of the translocating species resides inside the nanopore which leads to higher spatial resolution.

But in case of graphene nanopore the strong hydrophobic interactions between the nucleobases and graphene surfaces results in undesirable clogging and nonconsistent translocation times, affecting the functionality of the nanopore sensor. Also, the temporal resolution is still a major issue as the translocating speed of the DNA through 2D nanopore is still comparable with the silicon nanopores ($\approx$ 20-100 $\times 10^6$ nt/s).

So, in this master's project we will be primarily focusing on two factors:

- Reducing the interaction of the DNA with the nanopore to prevent unwanted clogging and nonconsistant translocation time.
- Controlling the translocation speed of the DNA through the nanopore.