Carbon Nanomembranes the Other Carbon-Based 2D-Material

Albert Schnieders
Polina Angelova, Nikolaus Meyerbröker, Henning Vieker

CNM Technologies GmbH, Meisenstr. 96, 33607 Bielefeld, Germany

albert.schnieders@cnm-technologies.com

Carbon Nanomembranes (CNMs) (Figure 1) are one molecular monolayer - equivalent to 1 nm - thin, Carbon-based polymeric films with properties which can be specifically adjusted for a variety of applications such as filtration or separation tasks. As a Carbon-based 2D-material, CNMs are related to graphene. However, they have many properties, which cannot easily be achieved for graphene. Their surfaces can be chemically or biologically functionalised (even differently on both sides). Perforation (e.g. for size-selective separation) can be intrinsically achieved during fabrication. The size distribution and density of pores can thereby be controlled by adjusting a few manufacturing parameters. Additionally, it is possible to convert CNMs into nanocrystalline graphene. A variety in production methods - from integration into large area membranes for industrial-scale separation to a transfer-free CMOS-compatible manufacturing of even free-standing CNMs for sensor applications - is feasible.

In this presentation we will discuss the developments in two of our current focus applications:

1. CNM-based filtration and separation membranes: CNMs exhibit extremely high permeance for water molecules and act at the same time as a barrier for other small molecules (He, N_2, CO_2, O_2, ethanol, 2-propanol, etc.). Therefore, CNMs are currently explored as highly selective layers for energy-efficient filtration and separation of fluids (especially water) and gases.

2. CNMs as functionalisation layer in sensing technology (Figure 2): Oligonucleotides such as aptamers can adopt complex three-dimensional structures, which can bind a target with high affinity and specificity. However, immobilisation of oligonucleotides on a surface often leads to loss of their structure due to surface interactions resulting in no target recognition. We have developed a nanointerposer based on CNMs to immobilise oligonucleotides and especially aptamers to surfaces via easy and fast click chemistry. The use of the CNM allows for maintaining the oligonucleotides' three-dimensional structure and thus their target binding properties. Interaction of bound targets with surface-sensitive sensors is still possible due to the 1 nm thickness of CNM.

Figures

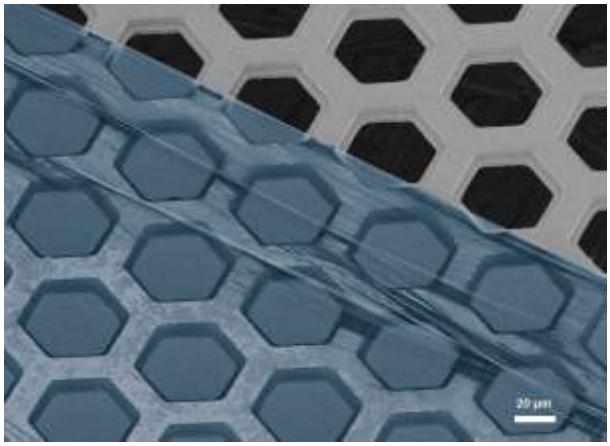

Figure 1: Helium Ion Microscope image of a free-standing CNM.

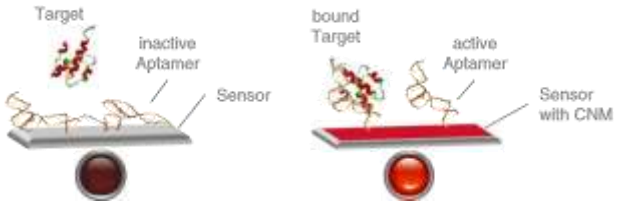

Figure 2: Principle of a surface-sensitive sensor with immobilised aptamers. Left: Target recognition is inhibited by interactions with the surface. Right: Using a CNM nanointerposer, aptamers maintain their three-dimensional structure and thus their target binding properties.