Carbon Nanomembranes as Sample Supports for TEM

Carbon Nanomembranes (CNMs) are 1 nanometre thin, thermally and mechanically stable – yet elastic – carbon films. They are the thinnest man-made polymeric membranes consisting of a single layer of densely packed, cross-linked aromatic molecules. CNMs can be transferred onto arbitrary surfaces or onto holey substrates resulting in free-standing membranes with a lateral dimension of up to several 100 micrometres.

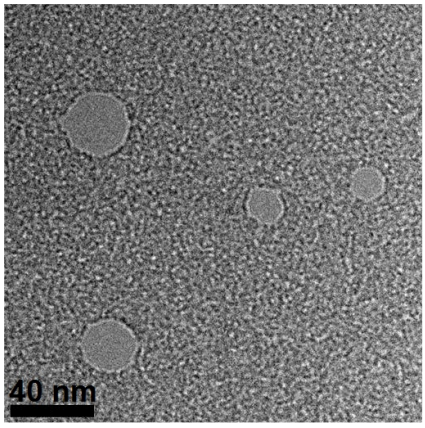

Fig. 1: TEM-image of CNM with nanopores. [1] Note the low contrast between the pore area and the CNM itself demonstrating the low background TEM-signal from a CNM sample support.

Conventional supports for transmission electron microscopy of nanometre scale samples are often thicker than the actual object, which results in a poor image quality. CNMs, however, are thinner (1 nm) than most nano-objects. Actually, they are the thinnest homogeneous support films available. CNMs are virtually contrast-free in TEM (Fig. 1), which improves the image quality for small particles significantly [2,3]. Even single atoms can be resolved. (Fig. 2) Only monolayer graphene gives less background TEM-signal than CNMs. However, graphene support films have typically domain sizes of a few microns and many areas with multiple layers of graphene. In contrast, CNMs are limited to 1 molecular monolayer (no multilayers) over the whole area due to their production. Additionally, graphene often suffers under contamination from Cu-crystals, which are residues from the substrate, on which the graphene film was grown in a CVD-process.

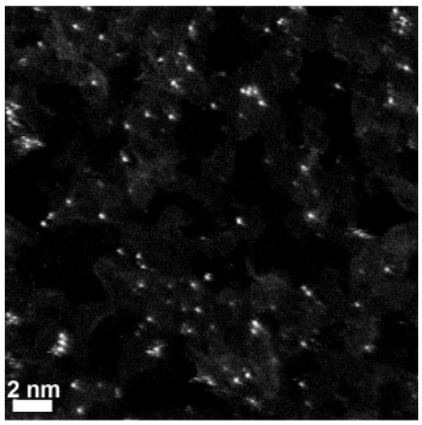

Fig. 2: STEM-image of single metal atoms on a CNM.

As a further advantage, the chemical functionality of CNM surfaces can be tailored to the specific sample preparation. Hydrogen- or amino-terminated surfaces are standard. Other functionalities (even complex biological molecules) can be immobilised to these surfaces. CNMs are also available as conductive membranes allowing for an easy dissipation of localised charge during analysis, which can often reduce image resolution. Thus, CNMs are the best sample supports for high resolution TEM of small structures and single particles.

CNMs have been also used as sample supports for cryo-electron microscopy. [4,5,6]

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