

# Nanopores in Silicon Nitride Membranes, Graphene and CNM: Milling and Imaging Techniques at the Helium Ion Microscope

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The Helium Ion Microscope (HIM) is a charged particle microscope employing helium ions for probing the sample. In the low dose regime, the HIM operates as microscope, high doses enable material modification and sputtering. Compared to conventional focussed ion beams (FIB) using metal ions like Gallium, the HIM offers a very small focal spot size down to 0.35 nm and a strongly localized sputter interaction with the material. We employ the HIM for both milling nanopores in free standing membranes as well as for the inspection of pores. The He<sup>+</sup> beam with its unique properties overcomes the resolution limit of conventional FIB tools as we show in a comparison with a high resolution Ga-FIB. We achieve smallest He<sup>+</sup>-milled nanopores with a diameter of about 4 nm in all investigated membranes: 30 nm thick Silicon Nitride, Graphene and 1 nm thick carbon nanomembranes (CNM) made from aromatic self-assembled monolayers by electron-induced cross-linking. Different strategies for the characterization of pores with the HIM will be discussed. In particular, we compare the feasibility of the ion generated secondary electron signal to the He<sup>+</sup> transmission signal.