Direct Determination of Forward Sputtering Rates and Redeposition for Focused Ion Beam Milling

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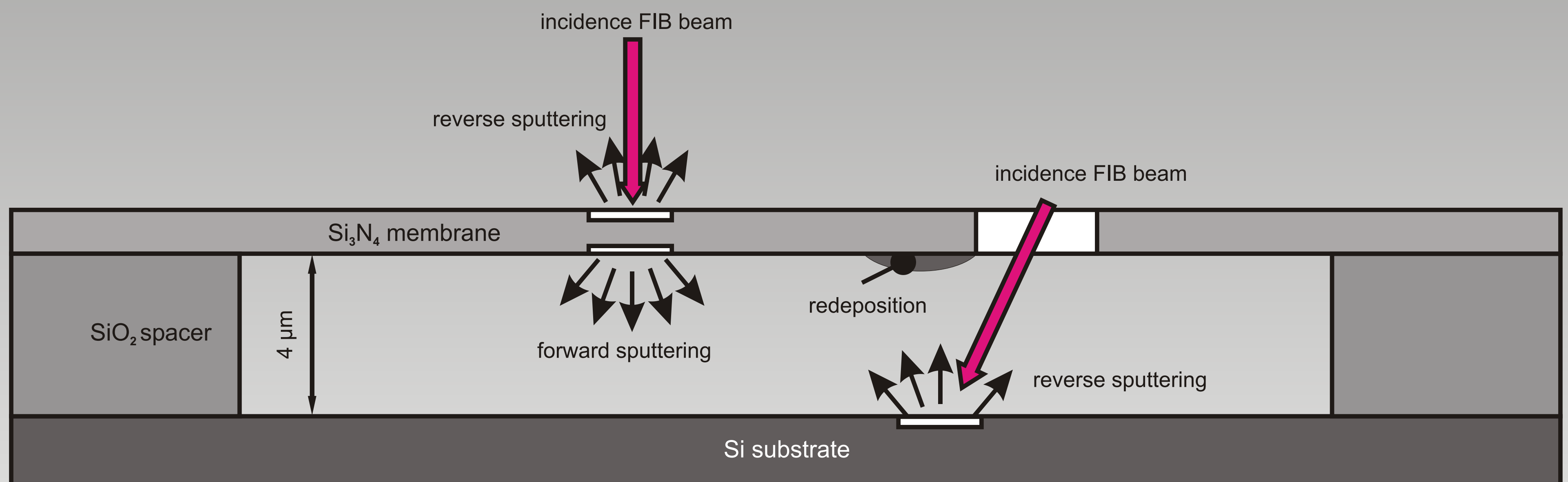
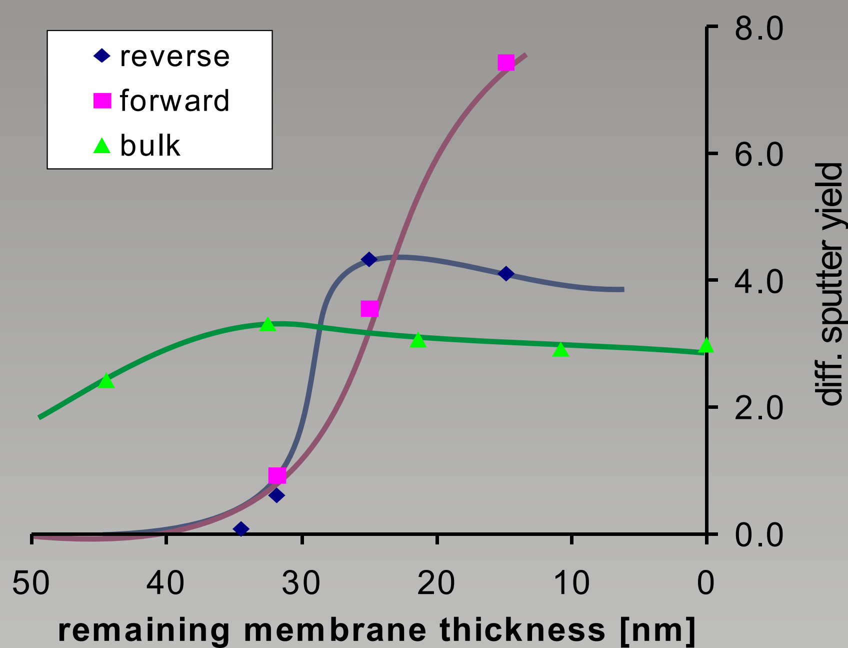
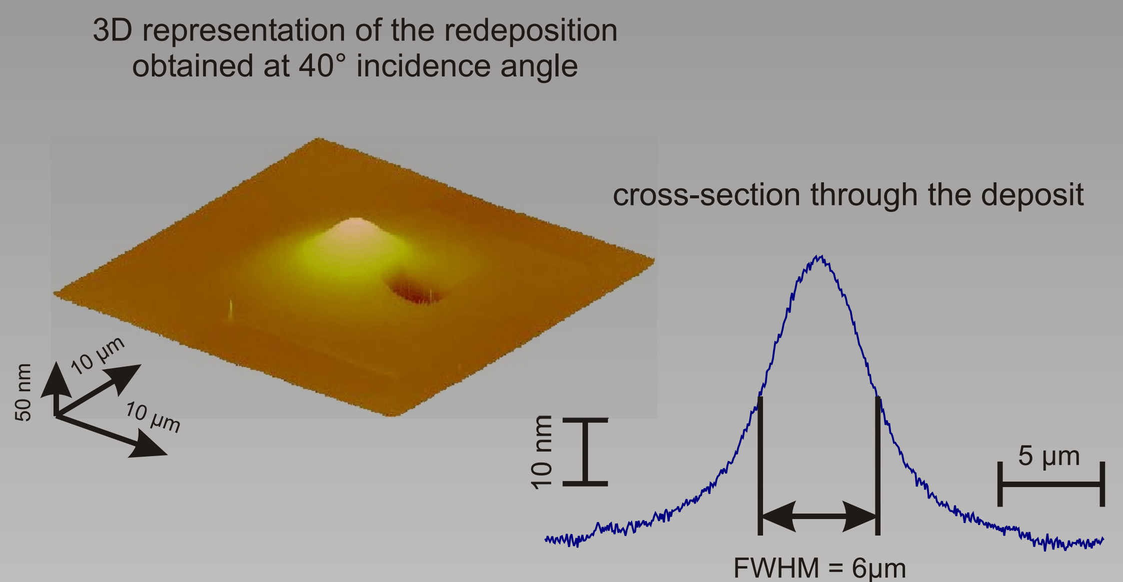
The use of thin membranes allows the direct measurement of both the forward and the reverse sputtering in a direct approach. We use 50 nm thick Si_3N_4 membranes and mill with 30 kV Ga ions. Characterisation of the milled structures is done by atomic force microscopy.

To determine the angular distribution of sputtered material a thin membrane, suspended above a silicon substrate with a distance of only 4 µm, allows to collect the material sputtered from the silicon substrate. The membrane is pre-milled to obtain holes through which the ion beam is directed onto the silicon substrate.







Results: For a membrane thickness of 50 nm, the ions still lead to a conventional reverse sputtering due to recoils. With the thinning of the membrane, the sputtering changes from reverse to predominantly forward sputtering with the forward sputtering yield increasing with decreasing membrane thickness, reaching about twice the value of the reverse sputter rate.

Results: All deposits have the same FWHM and are positioned directly above the milled hole, regardless of the incidence angle of the FIB.The material removal always occurs perpendicular to the substrate surface. Thus, for shallow milling (aspect ratio <1), the shape of the deposit is always the same for all incidence angles under investigation (0 - 55°).

FWF (Project P21703)

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