IMPROVED BURST PRESSURE OF LPCVD Si3N4 MEMBRANES BY NANOMETER THICK COMPRESSIVE ADLAYERS

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Si_3N_4 is a material widely used in MEMS technology. Its high mechanical strength makes Si_3N_4 attractive for applications where there is a need for ultrathin, yet robust, freestanding films, such as nanometer thick X-ray windows and support films for TEM. In this work, mechanical properties of Si_3N_4 and B-coated Si_3N_4 membranes were studied using a bulge test method. Burst pressure and corresponding membrane stress in Si_3N_4 layers were found to be significantly increased when a 3nm thick B layer was deposited on the top side of 25nm thick Si_3N_4 membranes, whereas a B layer applied to the bottom side of the membranes did not have an effect on the membrane strength. Using FEM simulations, we show that the B layer deposited at the top side decreases the maximum tensile stress in Si_3N_4 near the membrane edge, where a significant contribution to the total stress comes from bending. From this, we conclude that failure in single layer Si_3N_4 membranes during bulge test is dominated by fracture at the edge. The burst pressure of B-coated Si_3N_4 membranes was found to be higher for membranes with lower (more compressive) residual stress in B, which indicates that failure of bilayer membranes is caused by fracture initiated in the B layer.

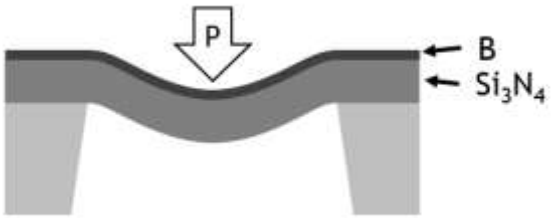

Figure 1 – Schematic of bilayer membrane during bulge testing

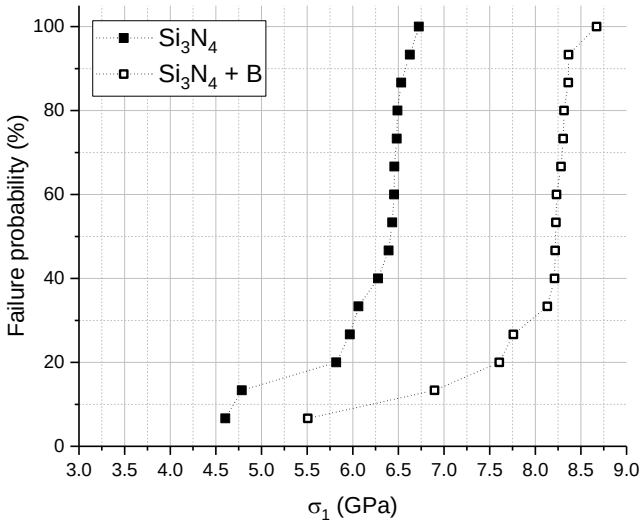

Figure 2 – Cumulative probability of failure vs. maximum membrane stress in Si_3N_4