Out-of-plane bending based on SiN-ion-irradiation and bilayer structures for easy access for micromanipulation

We present an approach for fabricating customized, replaceable tips for scanning probe microscopy of critical dimension and high aspect ratio structures. The tips are designed using in-plane nanofabrication, and subsequently folded out of plane to be accessible for micromanipulation onto scanning probe cantilevers. These tips, which we term “nanobits”, are fabricated with in-plane focused ion beam (FIB) milling, which allows aspect ratios of up to 10 in combination with tip radius of curvature down to 5–10nm. While definition of side-tips, double-tips and other application-specific tip shapes is trivial, the use of in-plane FIB milling to define the tip shape, requires that the nanobits are subsequently turned 90° out of plane to promote insertion into a cantilever probe for scanning. We compare here two different approaches towards such out-of-plane bending of nanobits: bilayer stress by deposition of a thin layer of metal or by direct exposure to ion beam. We find that the nanobits made in 100nm and 200nm SiXNy membranes tend to bend under FIB irradiation at similar residual thicknesses. In contrast to previously published results our approach suggests a way to eliminate the need for complex manipulation via microgrippers, so that the scanning probe cantilever can be used directly to pick up or to replace the scanning probe tip.

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