First lithography results obtained with the 2nd generation MeV proton beam writing facility

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At the Centre for Ion Beam Applications (CIBA) in the Physics Department of the National University of Singapore (NUS) we have established sub 100 nm beam spot sizes for MeV protons [1]. This improved performance has opened up new ways of structuring resist and Si as well as bio-imaging. The mass mismatch between proton and electron results in minimal energy transfer between an incoming proton and the substrate electrons. Therefore the secondary electrons generated have limited range, resulting in minimal proximity effects. Low proximity effects coupled with the straight trajectory and high penetration of the proton beam has revolutionized applications for MeV proton beams in lithography of high density and high aspect ratio 3D nano structures with well-defined smooth side walls [2].

A second generation proton beam writing (PBW) line has recently been installed at CIBA. This new system has shown superior focusing capabilities for MeV protons down to 13 x 30 nm^2 [3]. In this paper the first lithography results using the new PBW facility at CIBA will be presented and discussed. The new beam line facility, is based on the first generation PBW line in CIBA, it uses compact OM52 quadrupole lenses, with improved demagnification and a piezo driven target manipulator with 4 nm closed loop in X and Y direction. The following hardware and software improvements to the system will be discussed:

- Closed loop in the Z direction of 1 µm allows accurate structuring of resist material in the new PBW line.
- New Ni resolution standards, integrated onto a Si substrate allowing more accurate focusing.
- Electrostatic scanning system allowing fast, accurate scanning and better machining.
- Comparison of stage and beam scanning methods.

Finally the latest applications of PBW as a platform technique for mold fabrication will be presented, especially applications in the area of nanofluidic lab-on-chip devices for single DNA studies.

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