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P28 - Automatic beam focusing in the 2nd generation proton beam writing line

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Proton beam writing (PBW) can fabricate three-dimensional, high aspect ratio nano structures with vertical, smooth sidewalls and low line-edge roughness [1]. This technique has been used in many areas like photonics, micro or nano-fluidics, nano imprinting, silicon machining and mask for x-ray lithography.But as so far, unlike electron beam lithography or electron microscopy, proton beam writing technique is still under development. Focusing is achieved by manually adjusting the currents of the Oxford triplet lenses to get the minimum beams spot size. An automatic focusing system based on C++ had been developed and a sub-micrometer beamspot of approximately 600 nm × 700 nm was achieved in the first generation proton beam writing system [2].

Recently the 2nd generation PBW system has shown improved focusing performance down to 13 nm x 30 nm and a fine lithographic HSQ patterns with 19 nm line width and 60 nm spacing have been fabricated [3,4]. In order to make this system more convenient, a new automatic focusing program based on Labview is being developed. A high quality resolution standard with a sidewall projection of less than 5 nm is used to focus down the beam [5]. Scanning Transmission Ion Microscopy (STIM) and proton induced secondary electron microscopy provide the imaging information to characterize the beam. During the experiment, the beam is first manually focused on quartz to a spot of ~10 μm × 10 μm. Then the beam is scanned over the sharp edge of the Ni resolution standard to form an image. After that the user defines two lines, which cross the edge of the image in x and y directions. The data obtained is fitted by a modified Gauss error function to give the beam spotsize. The minimum beam size is found in each direction by changing the currents of the quadrupole power supplies. With this method, beam spot sizes of 30 nm x 80 nm have been achieved.

References

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