Individual beam control for MEMS multi electron beam systems

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Multi electron beam systems are being developed for high throughput lithography [1] [2], multi electron beam microscopy [3] and multi electron beam induced deposition (ebid)[4]. Both for lithography and deposition systems individual beam blanking is needed for patterning. It also has advantages to position, focus, vector scan and stigmate the beams individually.
The deflector arrays necessary for such individual control can be made only with MEMS technology. These deflector electrodes should have lateral sizes ranging from approx. 150 μm to 2 μm[5] [6]depending on their purpose. Currently the smallest octupoles used in miniaturized single beam electron columns have a typical lateral size of 1 mm[7].
One of the challenges is to design electrodes with a fabrication process that is compatible with chip fabrication and electron optical design rules. Furthermore it is desirable to control thousands of beams without having thousands of external control wires.
We have designed a proof of concept multibeam quadrupole deflector using MEMS technology for 25 beams. Our fabrication process is bipolar compatible allowing local electronics to be incorporated, for example enabling sample and hold functionality. The design of this device is depicted in fig. 1. The deflector electrodes itself will be made out of deposited Molybdenum because its surface oxide is conducting, thereby minimizing beam errors due to charging.
Fig. 2 shows the prototype etched in 2 μm thick deposited Aluminum for the purpose of testing our fabrication process. We have deposited 4 μm tick Molybdenum successfully. Furthermore we did a successful reactive ion etching (RIE) test on Molybdenum that shows that we are able to etch 4 μm deep anisotropically in Molybdenum.
We will present the fabrication process, fabrication results and electron optical deflection measurements that are ongoing.

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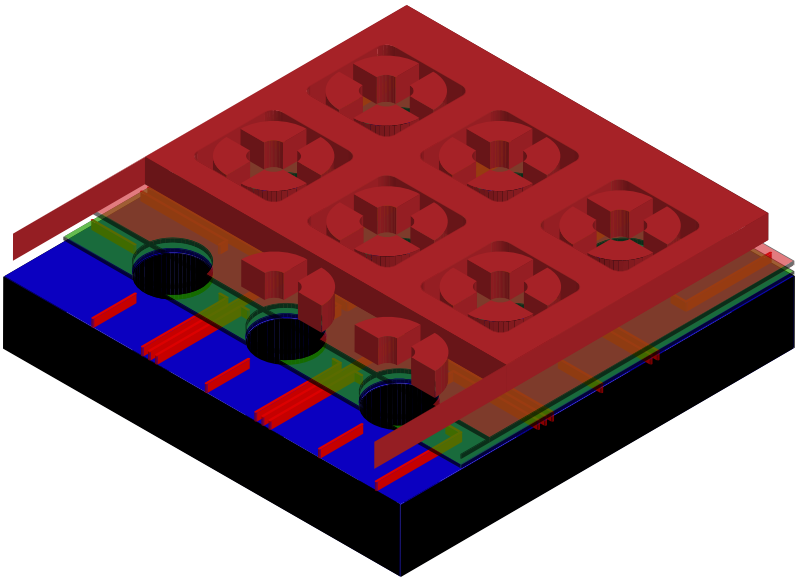

Fig. 1: Design sketch of quadrupole. Bottom blue layer; SiO2 base on Si wafer, Red wires: connection leads of the deflector, Green layer: insulating layer, Red top layer: Deflectors and ground plane etched out of deposited Molybdenum.

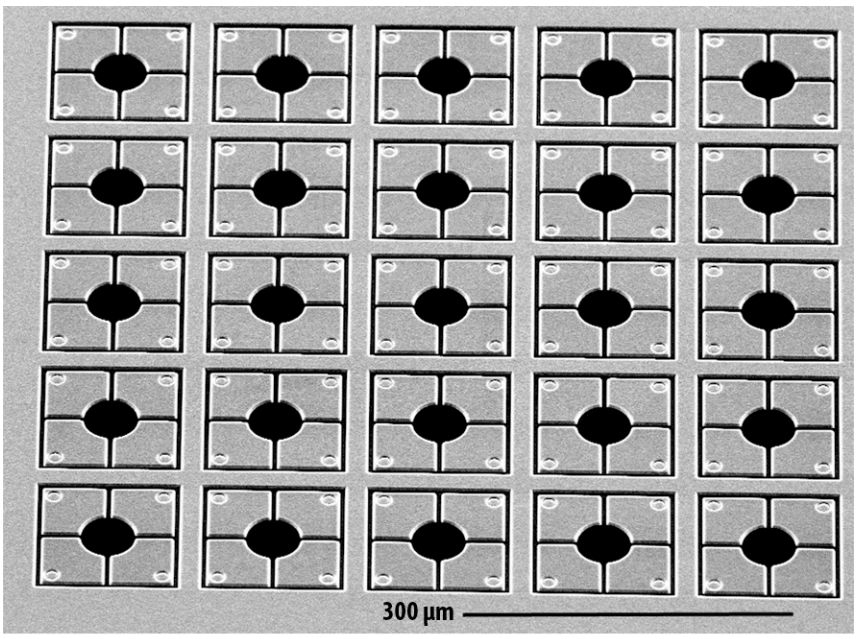

Fig. 2: Quadrupole process test prototype made out of 2 µm thick Aluminum.