Design of parallel mass detection using Focused Ion Beam columns

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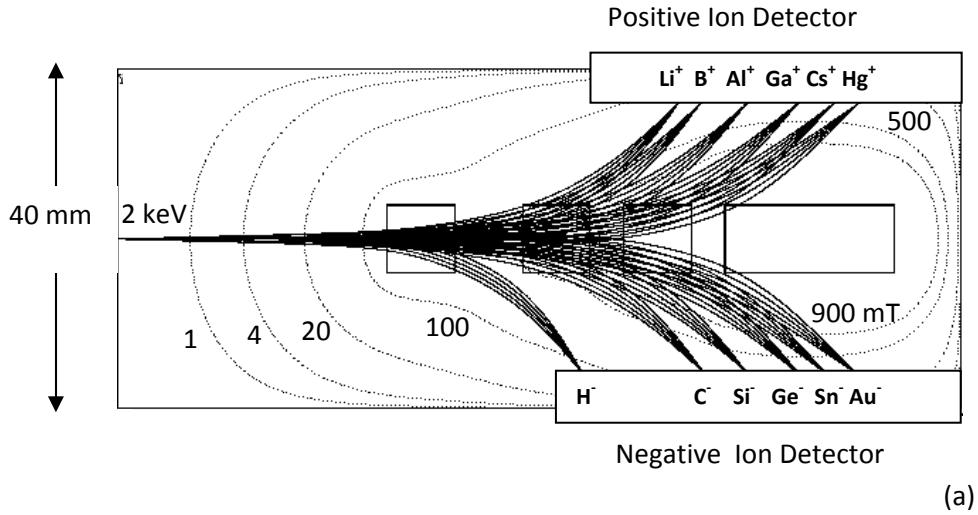
The possibility of combining Focused Ion Beam (FIB) columns with Secondary Ion Mass Spectrometry (SIMS) techniques has many potential benefits for the nanofabrication of semiconductor devices. In addition to routine topographic imaging, the relatively high probe resolution of FIBs (compared to conventional SIMS instruments), if combined with SIMS analysis, may be a way of obtaining material information relating to specimen changes/manipulation on the nano-scale. This possibility is brought closer by recent success with techniques that implant the specimen with reactive species such as oxygen and or cesium, or use oxygen flooding, increasing the FIB-SIMS yield by over two orders of magnitude[1]. Another important step towards this goal is to integrate a FIB column with a secondary ion column so that the high probe resolution for the FIB is maintained, typically less than 10 nm. This paper presents some spectrometer designs that may be suitable for this purpose.

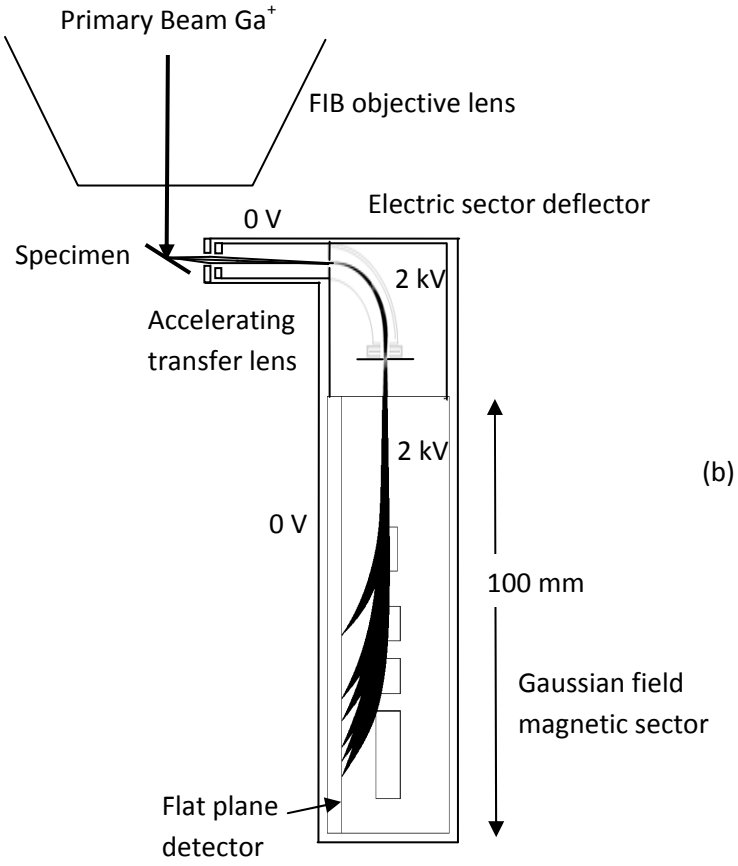
Fig. 1a shows simulated ray tracing ion trajectory paths for a compact parallel mass spectrometer that uses an asymmetric Gaussian shaped magnetic field deflector distribution for 2 keV ions that have an input angular spread ranging from -25 to 25 mrad. The rectangular regions in this diagram denote surfaces of constant magnetic potential (such as pole-pieces/permanent magnets) which excite a field distribution on the deflector mid-plane, indicated by magnetic field contour lines in Fig. 1a. Fig. 1b is schematic diagram of how such a parallel mass spectrometer unit might function inside the FIB specimen chamber. A lens close to the specimen accelerates secondary ions into a 90° electric sector, which corrects for the energy dispersion action of the magnetic mass spectrometer. The paper will present detailed simulations on how effective such an arrangement is expected to be.

References

[1] D. S. McPhail, L. Li, R. J. Chater, N. Yakovlev and H. Seng, Surface and Interface Analysis, SIA-09-0652, 2009



(a)



(b)

Figure 1: FIB mass spectrometer attachment

(a) Simulated direct tracing of 2 keV ions with emission angles over from -25 to 25 mrad

(b) Schematic layout in a FIB specimen chamber