MAR09-2008-004425

Abstract for an Invited Paper
for the MAR09 Meeting of
the American Physical Society

Direct writing of electronic circuits and micromachining by focused ion beam (FIB) implantation

ANDREAS DIRK WIECK, Ruhr-Universität Bochum, D-44780 Bochum

The maskless implantation of FIBs in semiconductors creates a local doping. In n-type conducting sheets, p-lines are written to insulate n-regions laterally from each other or vice versa. In this way, conducting areas can be biased with respect to each other. Narrow paths are easily driven into depletion, creating lateral transistor channels. The advent of multi-focussed-ion-beams allows a more parallel writing of such integrated circuits. For ion beam milling, a new long-life Bismuth (Bi) source is developed and employed [1]. Bi is the heaviest, non-radioactive element and has thus a maximal impact on the material to be sputtered locally. It is non-toxic, well available, mono-isotopic, and inexpensive, has a low melting temperature, and comes even in clusters and the single charged particles make up 95% of the whole FIB-beam. This means that the chromatic errors of the electrostatic Einzel-lenses in the FIB system are not important. Since heavy ions are slower than light ones at the same energy, Bi penetrates to a minimal depth into the target, leaving minimal contaminations. The sputter rate is about 5 times higher than the one of the usual Ga. Since Bi is the only element in this source, it is not necessary to separate it from other ions by a mass filter. Bi is thus a good candidate to improve the performance of sputter-FIBs ultimately, up to replacing Ga. We developed FIB - liquid metal ion sources of nearly all metallic elements in the periodic table. In this way, practically all dopants can be introduced into semiconductors after epitaxial growth in a full ultra-high vacuum process, which enhances the flexibility of the material choice enormously.

[1] P. Mazarov, A. Melnikov, R. Wernhardt, and A.D. Wieck, Long-life bismuth liquid metal ion source for focussed ion beam micromachining application, Appl. Surf. Sci. 254, 7401 (2008).