MeV micro beam as a commercial ion implanter? Results of a feasibility study

J. Meijer[1], Bernd Burchard[1], I. W. Rangelow[2], S. Kubsky[3]

[1] *Institut für Physik mit Ionenstrahlen, Ruhr-Universität Bochum, D-44780 Bochum, Germany*
[2] *Institute of Technological Physics, University of Kassel, D-34132 Kassel, Germany*
[3] *ACCEL Instruments GmbH, Bergisch-Gladbach, Germany*

High power devices or latch-up up suppression in logic or memory devices require three dimensional doping structures in Silicon. Today the common production technique is sequential epitaxial multilayer growth in alternating in combination with multiple subsequent diffusion and/or low energy ion implantation processes. The fundamental drawback is that epi-process techniques are time consuming, cost intensive and obtain low yield. An alternative technique is ion implantation. It allows for controlled, fast and cost effective doping with high homogeneity and reproducibility. However, structured high energy ion implantation requires a contact mask, so typical resists like polyimide are inappropriate: The thickness of the resist layer would have to exceed tens of micros. Furthermore it will be destroyed during high-energy ion impact. This yields in unstable results.

A first potential alternative is the use of Si-stencil masks as a shadow mask, as developed by Toshiba [1]. This method suffers from edge scattering and leads to diffused implantation profiles.

As a real alternative and applicable high volume production method we suggest the use of the high energy ion projection in combination with a fast vacuum stepper stage. A feasibility study in cooperation with a German semiconductor company [2] yields an estimated cost reduction potential of more than 30% for power devices with three dimensional structures. This study shows that the stencil mask is one of the key features and the most critical component to obtain high throughput numbers.

We will discuss the advantages of method, technical risks and the yield expected for typical applications. We compare these to standard techniques. Additionally we report the status of a new high volume vertical projection system for 300mm wafer size under development at the Dynamitron Tandem Laboratory of the Ruhr-University Bochum.

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Corresponding Author:
Dr. Jan Meijer
Institut für Physik mit Ionenstrahlen/EPIII
D-44780 Bochum
Tel. +49 234/3227310
Fax. +49 234/3214172
Email: Meijer@ep3.ruhr-uni-bochum.de