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Ion implantation technology architecture and modelling challenges

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Ribbon ion beams were introduced in the mid 90's. A broad beam ion implanter employs a high current density plasma source, a bending magnet to steer the beam, a collimator magnet to straighten trajectories and multipoles and rods across the beam path to tailor a precise one-dimensional beam current distribution. Furthermore, energy filters are used to decelerate ions and filter high energy neutrals [1,2]. One of the features that made these tools so successful in device fabrication is the precise control of the dopant concentration depth profiles at low energies. Examples of ion depth profiles and ion dynamic calculations using TRIM and TRI3DSTP will be shown [3]. The evolution of multiple other technologies, like plasma doping, directional doping, unique processing capabilities using large area RF plasma sources and ribbon beams will be described. For example, the plasma doping system enables source and drain shallow doping for fins and non-line of sight doping at high doses ~$5\text{x}10^{16}$ /cm^2. Unlike the beam line tools, ions are not mass analyzed, but instead the wafer is processed within the plasma chamber or in an adjacent vacuum chamber. Pulsed DC bias ranging from 0.1- 10 kV at frequency f~5- 400 kHz is applied to the wafer. The RF plasma is generated by an inductively coupled coil. This talk is focused on the beam generation from a plasma source, magnetic and electrostatic focusing, filtering and steering of an ion beam, as well as space charge simulations of low energy transport. In addition, we discuss modeling tools that are used to compute trajectories, space charge densities, electrostatic and magneto static potentials in 2D/3D space.

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