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Research and Development of an Ultrahigh Precision Single Ion Implanter

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Ion implantation is an accelerator technology essential for creating defects or introducing impurities into materials. A research and development study is currently underway at QST Takasaki Institute toward ultrahigh-precision single-ion implantation based on laser-cooling techniques. To achieve this, we incorporate a linear Paul trap as an ultracold single-ion source, where trapped ions can be cooled to the order of mK or even "Coulomb-crystallized"by Doppler laser cooling. In our scheme, N or Si ions, useful for ion implantation to create color centers, are sympathetically cooled down to the mK range through Coulomb collisions by co-trapping them with laser-cooled Ca ions. Then, the ions are extracted selectively from the trap to be accelerated and focused through a 50-kV electrostatic bipotential lens system. We aim to focus the ions on the order of 10 nm for ultrahigh-precision implantation. The implantation system has already been assembled, and the commissioning is currently underway to enable ion extraction using a Coulomb crystal and focusing extracted cold ions. We present the status of system development and outline the scheme for selective ion extraction and nanobeam focusing based on multiparticle simulations.

Footnotes

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