INTEGRATED ENGINEERING SOFTWARE

Sami Hahto, Chief Scientist at Nissin Ion Equipment USA Inc, discusses the benefits of using LORENTZ software in the design of ion implanters.

Nissin Ion Equipment USA Inc (formerly SemEquip), is the technology leader in the development of cluster ion implantation sub-systems and advanced ion source materials for the manufacture of logic and memory chips. Nissin Ion Equipment's technologies enable the utilization of cluster beam ion implantation for manufacturing the world's most advanced integrated circuits at the lowest cost and highest throughput. Ion implantation is a crucial step to dope silicon semiconductor wafers at various stages of integrated circuit fabrication.

Dr. Sami Hahto, Chief Scientist at Nissin Ion Equipment USA, uses LORENTZ for all aspects of designing the systems. LORENTZ is one of INTEGRATED's most popular simulation tools, already recognized for providing fast and accurate results, modeling of boundaries and easy analysis of open region problems.

Nissin Ion Equipment develops subsystems for ion implanters: starting from the creation of the ion source, they design the front end of the implanter consisting of the ion source, beam extraction systems and also beam line components like mass analyzer magnets, electrostatic lens elements and quadrupole magnets.

LORENTZ allows Hahto a detailed analysis starting from the source, which is the first component in the system. In general, plasma sources are used, either RF or ECR (electron cyclotron resonance) or discharge sources. Nissin Ion Equipment has developed what is called “electron-impact” source. This type of source is needed since they use materials that are heavy clusters (cluster molecules which have up to 40 atoms in one cluster, instead of one or two), making them very fragile. Ionization is very delicate so they use electron beams. Electron beam is emitted from an electron gun, and shot around a 90 degree bend into a source ionization chamber where it ionizes the clusters.

In the source alone, Nissin Ion Equipment has two permanent magnet circuits that are independent. Both are very important: one is part of the electron beam formation and bending; the other one is for plasma confinement. Both circuits are designed with LORENTZ, and always have been. “We have had great success,” Hahto comments. “We have designed several generations in the last six years using mostly 3D LORENTZ. Our fairly complicated permanent magnet circuits and electrostatic electron extraction optics need to precisely focus, secure and trap the electron beams and plasma.”

The company has designed the whole electron gun - the first part of their system - using LORENTZ. That includes the magnetic, electric and charged particle/electron beam modeling. Solidworks is the CAD package used for drafting the designs and then they are very seamlessly imported into LORENTZ. Once modeling, Hahto mostly does all the changes in Solidworks, defines the models in LORENTZ and then runs them.

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Sami Hahto, Chief Scientist at Nissin Ion Equipment USA Inc, discusses the benefits of using LORENTZ software in the design of ion implanters.

Hahto explains: "It's been very successful for us, prototyping and productization. We do one prototype and then we productize with minor modifications. LORENTZ is so precise that we do not need multiple prototypes and we can cut a lot of development cycle time. In the past, before the software was there, it would have taken much longer."

When comparing LORENTZ with other particle trajectory analysis software packages, Hahto annotates that INTEGRATED's package is much more seamless in terms of user interface, more graphical, easier to learn, but also the importing of the CAD data is a key feature. "What I love about LORENTZ," he continues, "is the surface meshing, basically the boundary element adaptability: that's the big advantage. You can actually model things that are much larger in reasonable time. You can have precision where you need it. The automatic meshing is very good, but I actually prefer doing my own meshing most of the time. If you know how to do that, you can select the meshing to have the precision only where you need. It can speed up the models a great deal compared to the finite elements in other software packages. That's where the differences are most evident."

As mentioned above, Hahto designs also electrostatic ion extraction systems, which form the ion beam. This process involves designing electrostatic structures that are biased to high voltage and pull out the ions from the ion source and form and focus the ion beam injecting it into rest of the beam line. That ties into one important part of their system: high voltage insulators. Nissin Ion Equipment has large - 100 kilovolt - insulator bushings, isolated from ground, that hold the whole ion source and the front assembly. They use LORENTZ for designing the devices. Hahto has used 2D but mostly the 3D version, achieving very good results. "We had an older design that was done basically semiempirically before I joined the company," Hahto comments. "Then, in the last two years we used LORENTZ to design these new insulators, looking into triple point stress shielding and surface fields, and we had quite good success."

Nissin Ion Equipment faced another complex ion optical problem that they solved using Lorentz; they managed to increase the beam currents of the lowest energy ion beams by almost a factor of ten by designing decel lens in the beam line to decelerate and focus the ion beam to the semiconductor wafer. LORENTZ's capability to accurately model charged particle beam space charge was critical for this development.

Hahto has also used LORENTZ in the past for projects related to negative ion extraction systems for fusion research and accelerator applications like medical isotope production. Neutron generators are another area where Hahto has utilized LORENTZ. These are basically generators that use 100KV deuterium or tritium beams shooting on titanium targets and creating neutrons for cargo screening or other similar applications.

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