High Brightness Plasma Ion Source Developments for Next Generation FIB and Surface Analysis

N. S. Smith, P. P. Tesch, N. P. Martin
Oregon Physics, 2704, SE 39th Loop, Suite 109, Hillsboro, OR97123, USA
R.W. Boswell
Oregon Physics, 17 Wongoola Close, O'Connor, ACT 2602, Australia

Great advances are being made with inductively coupled plasma (ICP) ion source technology [1-3]. In particular, the brightness, stability and lifetime have now greatly surpassed all other plasma source technologies used today for scanned ion beam techniques [4].

By transferring energy to plasma electrons via a radio frequency induction field, it is possible to create a plasma state without a cathodic electrode, such that the maximum plasma potential is marginally above that of the local boundary (ie <20V). Ions generated in such a plasma, will diffuse to the outer plasma sheath and accelerate into the chamber walls, but with an impact energy that causes negligible sputtering. This method of plasma creation can create high plasma densities (>5×10^{12} ion cm^{-3}), coupled with very low mean thermal ion energies (<0.05eV), providing the conditions required for energy normalized beam brightness values that now exceed 1×10^4 $Am^{-2}sr^{-1}V^{-1}$. This high brightness can be attained with long lifetimes (>>2000 hours), stable beam current (<±0.5% drift per 30 minutes) and an axial energy spread for the extracted ion beam of 5-6eV and for a broad array of ion species.

While this technology is already capable of generating smaller probe diameters than the liquid metal ion source (LMIS) FIB at beam currents in excess of 20nA, the future for this technology promises to be even brighter. This paper describes the operating principles of an inductively coupled plasma source, the properties of the ion beam(s) being created and the projected future for this technology.

ICP sources are now being employed for secondary ion mass spectrometry (SIMS), as well as for surface engineering and sample preparation with FIB, with unprecedented results. Here we present data from both of these ion beam techniques, to exemplify the impact on surface science.

References

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