Introduction

A high intensity cesium ion source, as well as a new sample changer are being developed and designed at PRIME Lab. The ion source is based on the CAMS ion source developed at Lawrence Livermore National Laboratory [1]. Various aspects of the ion source performance are being modeled using Simion 7.0, which iteratively solves Laplace’s equation. Simion 7.0 does not require cylindrical symmetry so the effects of non-symmetric components, in particular the sample insertion rod and immersion lens (aperture above the surface held at cathode potential), can be explored.

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Results and Discussion

Two types of simulations were examined. In the first the trajectories of Cs+ ions emitted from the surface of the spherical ionizer were examined. Ions were emitted with a random energy distribution centered around 0.15 eV that could vary by ±0.1 eV. The ions were emitted at randomized angles to the surface of the ionizer. The emission of the secondary ions (min 10%) was limited to the diameter of the cathode hole and the ions were emitted with a random energy distribution centered around 15 eV. Simion has several choices for charge repulsion. Ion beam repulsion was not used since the program requires that all of the ions start in the same plane (clearly not tolerable in the case of the cesium ions). Thus, ion cloud repulsion was used. In this model, each ion represents a cloud of ions. Since Simion is not Child’s Law restrained and the manual states it does not model space charge in ion source regions well, care was taken to make sure that the results from simulation mimicked experiment and other ion source simulations. When the trajectories of the secondary ions were examined, over 90% of the charge was described to a cloud of cesium ions that the secondary ions had to fly through. The version of the Livermore source that Tom Brown uses to start his point in his ion source modeling paper [2] was used as our comparison throughout the simulations.

One of the obvious differences between the PRIME Lab source and existing cesium spalder ion sources is the size of the ionizer. Since the Chalk River spalder source design is being used for this ion source housing is centered in the sample rod and the cathode must be recessed with the result that one side of the immersion lens is very close to the sample rod. To increase this distance (and conductance of the ion source) we increased the size of the ionizer. The new spherical ionizer will have a radius of 0.945" as opposed to 0.687" on sources made by HVJE. After the immersion lens was decided upon, the space charge and voltage were scaled up so that approximately the same current density different starting positions on the ionizer surface. Figure 4 shows secondary ions being emitted from the cathode and transported out of the source through the central hole of the ionizer. This view would be represented in the two sources. The distance from the cathode to immersion lens and from the ionizer to cathode was varied in both sources. The cesium focus and the divergence and spatial spread of the secondary ions were examined in many different geometries. It was found that the distance between the front of the sample and the ionizer should be 1.4" and the distance between the back of the immersion lens and front of the sample should be 0.24". The space sample insertion rod will be able to move 0.25" in the z direction. The cesium focus and approximate emittance of the secondary ion beam agreed to within a few percent of each other in the optimal geometry for the two sources.

Different immersion lens geometries were examined. One simple rule of thumb is that if the immersion lens is to be moved further away from the cathode, then the immersion lens aperture should be increased so that approximately the same current density different starting positions on the ionizer surface. Figure 4 shows secondary ions being emitted from the cathode and transported out of the source through the central hole of the ionizer. This view would be represented in the two sources. The distance from the cathode to immersion lens and from the ionizer to cathode was varied in both sources. The cesium focus and the divergence and spatial spread of the secondary ions were examined in many different geometries. It was found that the distance between the front of the sample and the ionizer should be 1.4" and the distance between the back of the immersion lens and front of the sample should be 0.24". The space sample insertion rod will be able to move 0.25" in the z direction. The cesium focus and approximate emittance of the secondary ion beam agreed to within a few percent of each other in the optimal geometry for the two sources.

References