Progress Towards a Commercial Neon Gas Field Ion Source

FHM Rahman, S. Sijbrandij, L. Farkas, R. Percival, J. Notte,
Carl Zeiss Microscopy, One Corporation Way, Peabody, MA 01960, USA
notte@nts.zeiss.com

Historically, many early researchers have sought to operate the gas field ion source (GFIS) with neon gas to produce a high brightness neon beam. This work was motivated by the prospects of a highly focused ion beam to enable sputtering and beam chemistry. The possible applications include nanofabrication (including mask repair and circuit edit) and analysis by secondary ion mass spectrometry (SIMS). However, these early works were thwarted by several technical issues that make the consistent and reliable operation of the neon GFIS difficult.

Among the difficulties of implementing the neon GFIS is the fact that the emitter material tends to degrade rapidly over time when it is operated at the large electric field strengths required for neon emission. There is emitter damage in the presence of neon gas due to gas impurities, and due to negative secondary ions created as the neon beam strikes nearby surfaces. The angular emission pattern is also observed to change ("site swapping") on timescales ranging from 10 ms to 10 seconds. Finally, the high voltages surrounding the emitter can induce Paschen breakdown of the gases between the various electrodes. This presentation will include a detailed and quantitative review of these adverse effects.

Despite all of these technical challenges, work towards a neon GFIS continues. At present, under laboratory conditions, the neon GFIS can be realized in a limited capacity. Experimental measures of stability, lifetime, energy spread, and brightness will be presented. Also presented will be some simulations and early experiments of the neon beam's sample interaction.

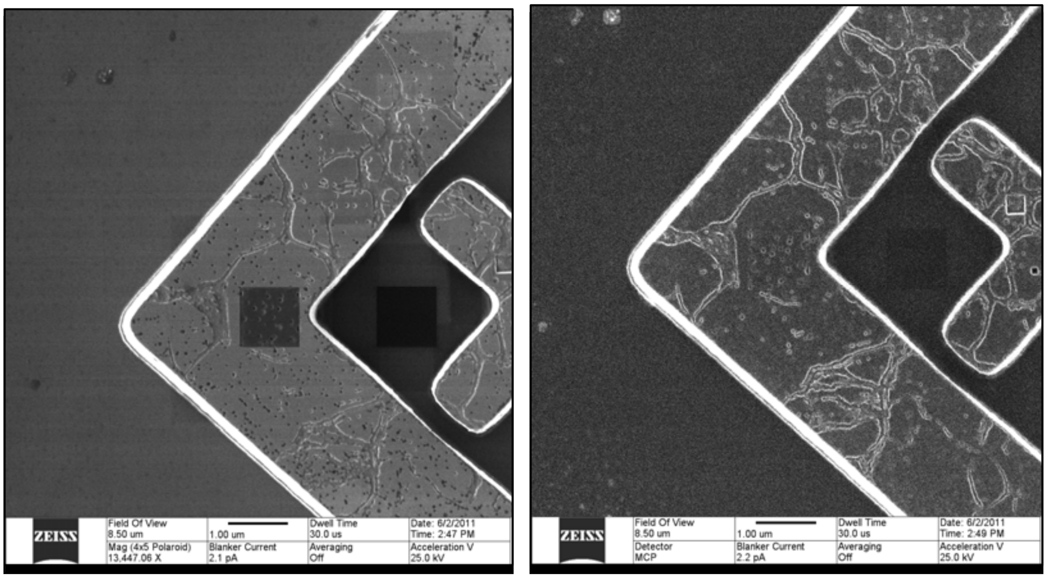

Figure 1: An early experimental image attained with a ~ 2 nm focused probe of 25 keV neon ions. The detected particles in this case were secondary electrons (left) and secondary positive ions (right). The horizontal field width is 8.5 microns. The sample is composed of a patterned aluminum feature on a silicon substrate.