Advanced Ion Microscopy Focus Topic
Room Hall B - Session HI-ThP

Advanced Ion Microscopy Poster Session

HI-ThP-1 He+ and Ne+ Ion Beam Resolution Dependency on Beam Energy, ***Waqas Ali,*** Intel Corporation, USA*; S Tan,* Intel Corporation*; R Hallstein, R Livengood,* Intel Corporation, USA

For several decades, Gallium (Ga+) remained an ion species of choice for circuit edit (CE) applications due to its excellent micro and nanomachining capabilities. But due to continuous device scaling, now it is becoming highly challenging to fulfill all the needs of CE with Ga+ based focused ion beam (FIB) tools. Recently Neon gas field ionization source (GFIS) has emerged as one of the most viable solutions to supplement CE requirements where a Ga+ FIB falls behind [1]. A lot of effort has gone into the beam characterization of the Neon (Ne+) and Helium (He+) beams of Orion NanoFab that is the first GFIS based commercial tool. In this paper, we present our results on resolution characterization of He+ and Ne+ beams as a function of beam energy.

He+ beam resolution characterization was done at 10, 20 and 30 kV beam energies whereas Ne+ beam resolution was characterized at 10 and 25 kV. The test was conducted on CVD graphene on TEM grid and ImageJ was used for image analysis. The lateral resolution for Helium was 0.54 ± 0.07 nm at 30 kV beam energy whereas for Neon the resolution was 2.45 ± 0.46 nm at 25 kV beam energy both with 100 fA beam currents. The unparalleled resolution specs. of Ne+ and He+ ion beams have made them attractive not only for CE but for many other applications like high resolution imaging for fault isolation, failure analysis, EUV mask repair, lithography, graphene pattering, plasmonics and biological imaging etc. [2].

Reference:

1. S. Tan and R. Livengood “Applications of GFIS in semiconductors”, book chapter, Helium Ion Microscope, pp 471-498, Springer (2016).

2. J. Orloff, "Fundamental limits to imaging resolution for focused ion beams", Journal of Vacuum Science and Technology B, vol. 14, pp. 3759 (1996).

HI-ThP-2 ***Focused Cs Ion Beam-Induced Deposition and Gas Assisted Etch Characterization Results for 10nm Circuit Edit Applications*****, Roy Hallstein**, *R Livengood, M Ly,* Intel Corporation, USA*; Y Greenzweig, Y Drezner,* Intel Corporation, Israel*; B Knuffman, A Steele, A Knuffman,* zeroK NanoTech

Focused Ion Beam Gas Assisted Etch (GAE) and Ion Beam Induced Deposition (IBID) are used extensively in Circuit Edit nanomachining. Historically the Gallium Focused Ion Beam (FIB) has been the primary ion source technology for Circuit Edit applications. [1, 2] More recently, the neon and nitrogen (N_2) gas field ion sources (GFIS) have also been introduced to enable very small, high precision nanomachining for circuit rewiring and mask defect repairs respectively. [3, 4, 5] Other emerging ion source technologies are the so-called ‘cold ion’ sources, which ionize atoms that have been laser-cooled to micro-kelvin temperatures. These sources have been shown to have high brightness and low energy spread, enabling small focal spot sizes. [6] Two such emerging ‘cold’ sources that produce cesium ion beams are under development by zeroK NanoTech Corporation and Tescan Orsay Holding. [7, 8]

As part of the due diligence to identify breakthrough ion beam technologies to keep pace with nanomachining applications scaling requirements, we have completed preliminary analysis of the attributes of cesium for Circuit Edit applications. In this paper, Proof of Concept 10nm Circuit Edit results using the zeroK Nanotech Cesium ion beam-based GAE and IBID will be presented. Preliminary results include GAE chemical etching of semiconductor materials and IBID results for dielectric and metal depositions. Finally, preliminary electrical test results of proof of concept Circuits Edits on 10nm process node will be presented.

Author Index

Bold page numbers indicate presenter