Neon GFIS Gas Assisted Etch and Beam Induced Deposition Characterization for Semiconductor Applications

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Focused ion beam (FIB) induced silicon micro and nano machining is used extensively by semiconductor industry to support circuit analysis and modification. FIB machining is used in a variety of applications including: TEM sample preparation, micro-strip back, circuit cross-sectional analysis, photo-mask repair, and circuit design modification, -supporting every aspect of ramping a new processes technology and bringing a new product to market. A key challenge for technologists in this area is to continue to scale FIB machining capabilities at the same rate as Moore's Law (2X increase in transistor density every 2 years).

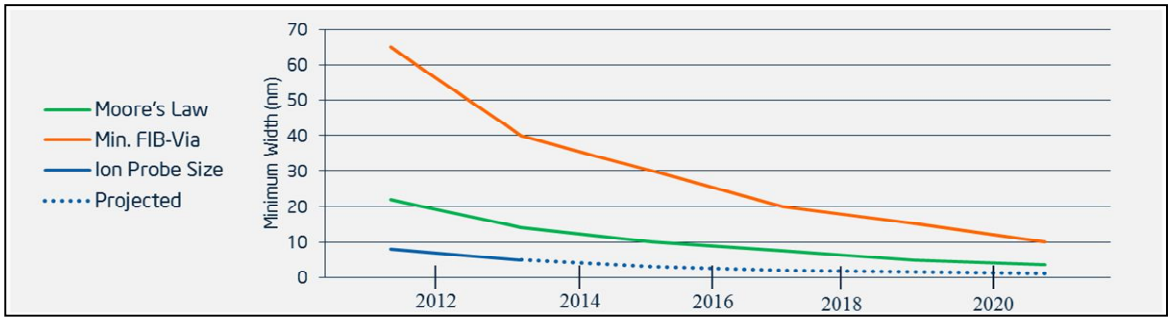

***Figure 1**: FIB beam profile and nanomachining requirement scaling projections as a function of Moore's Law.*

In order to help scale ion beam technology, Intel silicon debug research has been at the forefront of driving new development to enable ion beam scaling to intercept future generation process technology nodes (e.g., 10nm, 7nm, and 5nm). Intel's research initiatives span from working with FIB suppliers, national labs, and universities to identify and develop next generation ion beam technologies to enable smaller and smaller machining capabilities to keep up with the process scaling treadmill. One such research focus has been in the area of *Gas Field Ion Sources (GFIS)* technology, supporting the development and commercializing various GFIS ion species for sub 10nm nanomachining applications. Some of the most recent work, and the focus of this talk, is Intel work on developing-optimizing novel neon GFIS chemical assisted via milling and neon ion beam induced deposition (IBID) to support circuit rewiring. In this talk, the authors discuss the beam and GIS requirements for nanomachining and will present recent results of neon FIB chemical assisted via machining and beam induced dielectric / organometallic depositions for circuit edit applications.

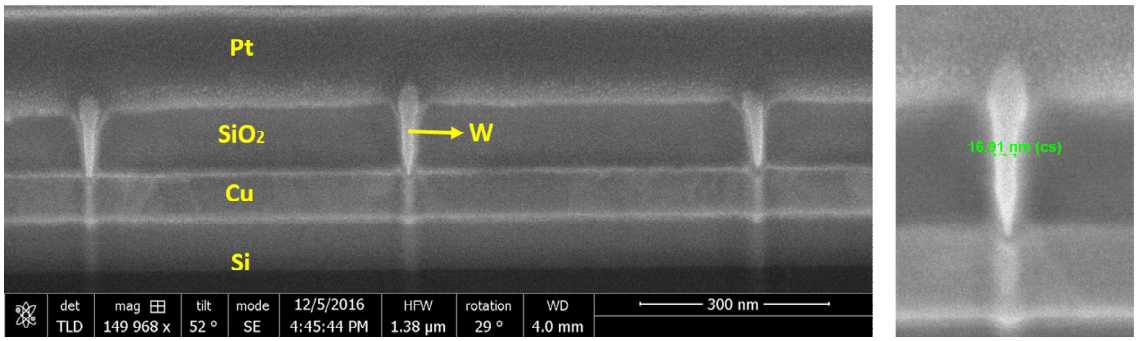

***Figure 2:** Cross sectional image of direct write FIB-Vias nano-machined and filled with $W(CO)_6$ Neon GFIS FIB and BID process respectively. FIB-via depths are 100 nm deep with a width an average width of ~ 17 nm.*