Acuity of Electron-Beam Induced Deposition of Pt/C Composite Material.

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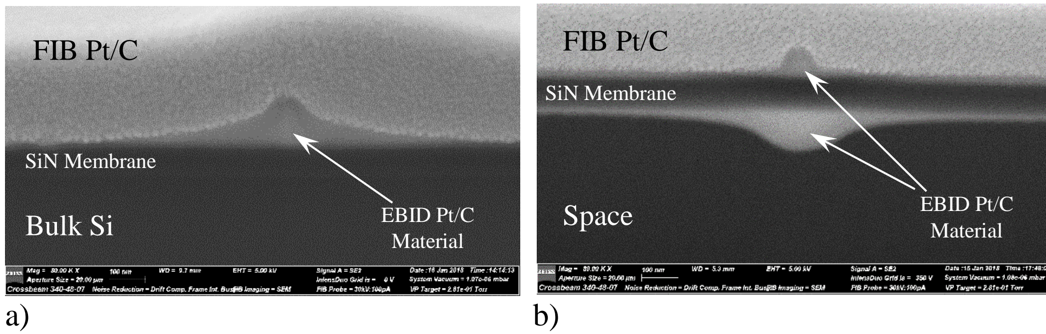
Creating conductors in prototyping of micro- and nano- electronic devices and in modification and debugging of integrated circuits (Circuit Edit) is routinely done by Ion-Beam Induced Deposition (IBID) from organometallic precursors. Latest semiconductor devices however could be damaged by IBID of conductors because of reduced thickness of interlayer dielectrics becoming comparable with depth of substrate damage that is inherent to the ion beam. Electron Beam-Induced Deposition (EBID) is an attractive alternative to IBID because of absence of the permanent beam-induced substrate damage under the deposition site. Unfortunately high resistivity of electron-beam deposited metal/carbon composites deposited and spurious deposition surrounding location irradiated by the electron beam complicate EBID use in Circuit Edit application.

To evaluate the acuity of EBID Pt/C composite was deposited from organometallic precursor by creating a series of single-beam-width lines over thin SiN and thick SiN/Si substrates. Accelerating voltage of the electron beam was varied, while beam raster parameters remained constant. Material deposited over thin SiN membrane demonstrated improved localization near the location irradiated by electron beam (Fig. 1) in comparison to the deposition on thick substrate. Deposition was also observed on the underside of SiN membrane, as visible on cross-section images. Difference in secondary-electron SEM image contrast between top-side and underside EBID material suggests possible difference in Pt/C composition.

Here we will present the relationship between the acuity of EBID to the accelerating voltage of the electron beam and its PSF-estimated profile, and compare to the acuity of 30 KeV Ga^{+} IBID (Fig. 2) in relation to the estimated profile of the ion beam [1].

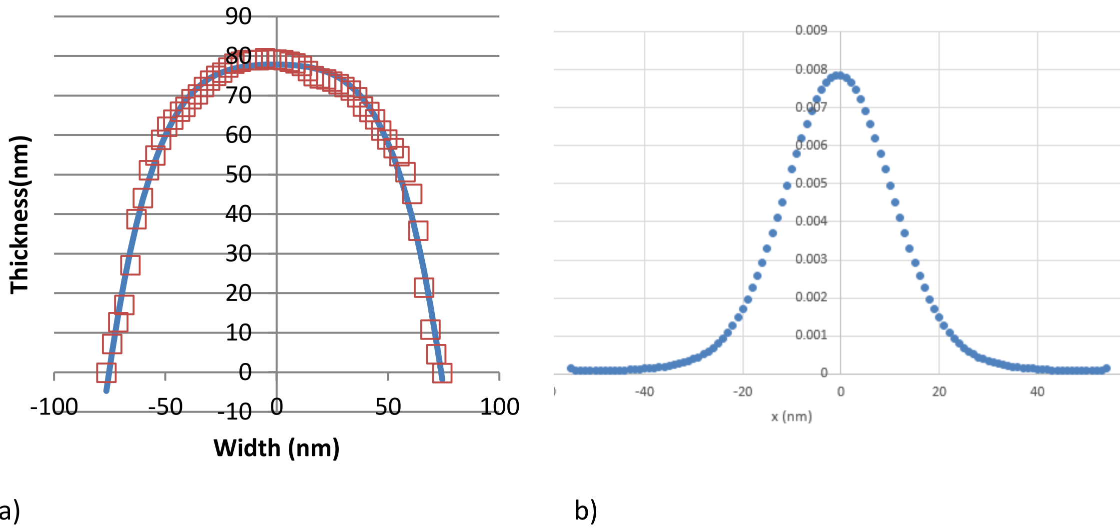
[1] E. Chang *et al*, JVST B 34(6) 2016 06KO01, doi:10.1116/1.4968537



a) b)

Figure 1.

Cross-sections of single-beam-width lines of EBID Pt/C composite material deposited from organometallic precursor by 5keV 12.6nA electron beam with same raster parameters over (a) thick SiN/Si and (b) thin SiN substrates.



a) b)

Figure 2.

Deposition profile (a) of IBID Pt/C composite by 24pA current of 30 keV Ga^+ ion beam and (b) corresponding reconstruction of ion beam current density distribution.