Type of presentation: Poster

IT-13-P-2485 Characterization of Ga^+ FIB Damage in Electron Beam Induced Deposited Platinum, Tungsten and Carbon Chemistries for In-situ S/TEM Sample Preparation

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TEM/STEM sample preparation by focused ion beam (FIB) and SEM/FIB instrumentation has become routine in the last several years. Technology advances in automation and in-situ techniques have reduced preparation times for sub-50 nm lamellae to less than an hour and with state-of-the-art technology less than 30 minutes [1]. DualBeams (FIB-SEM) are also often used for micro- and nanoprototyping applications. For S/TEM sample preparation electron or ion beam induced deposition (EBID, IBID) is required to planarize the region of interest to minimize artifacts generated by the FIB [2].

Many studies have investigated surface and sidewall lamella damage in Silicon by FIB [3]. In addition to sidewall damage by FIB for cross-sections or FIB processed S/TEM samples, surface damage must also be considered for FIB preparation especially when characterization of the sample surface is required. It has been shown that low energy electron beam induced deposition (EBID) imparts the smallest surface damage when compared to Ga^+ ion beam induced deposition (IBID) [4]. However, the rate of deposition with EBID is ~ 20X slower than IBID, thus understanding the damage depth into EBID layer during the FIB deposition process will reduce process time for cross-section or S/TEM sample preparation.

Approximately 100 nm EBID C, W and Pt layers were deposited onto Si using 5 keV; 6.3 nA (C and W) and 2 keV; 6.3 nA (Pt). 30 keV Ga^+ IBID C, W and Pt layers were deposited over the layers of interest and FIB prepared for STEM in SEM analysis. A 5 keV Ga^+ FIB Pt IBID over 2 keV Pt EBID sample was also prepared. Each face of the lamellae was FIB milled using Ga^+ ions at 30 keV and 88.5 degrees incident angle, followed by 5 keV at 85 degrees incident angle. Figures 1a and 1b are STEM in SEM images of the Pt and C experiments respectively. Measurements (Figure 2) reveal that IBID tungsten penetrated approximately 15 nm into the EBID tungsten while the IBID platinum penetrated more than 3X deeper into EBID platinum. This value decreased to approximately 16 nm when 5 keV IBID was employed for Pt.

Acknowledgement:

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[2] Introduction to Focused Ion Beams, eds. L.A. Giannuzzi and F.A. Stevie, Springer (2005).
[3] L. A. Giannuzzi et al., Micros. Microanal., 11(Suppl 2) (2005), p. 828.
[4] B.W. Kempshall et al., J. Vac. Sci. Tech. B, 20(1) (2002) 286.

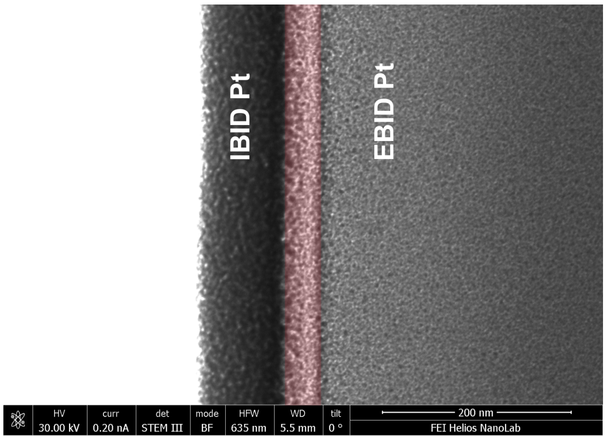

Fig. 1: 30 keV STEM in SEM images of surface 30 keV Ga+ FIB damage during Pt IBID into EBID Pt

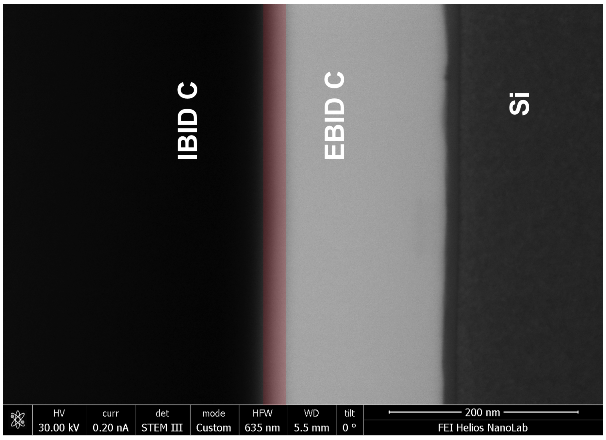

Fig. 2: 30 keV STEM in SEM images of surface 30 keV Ga+ FIB damage during C IBID into EBID C

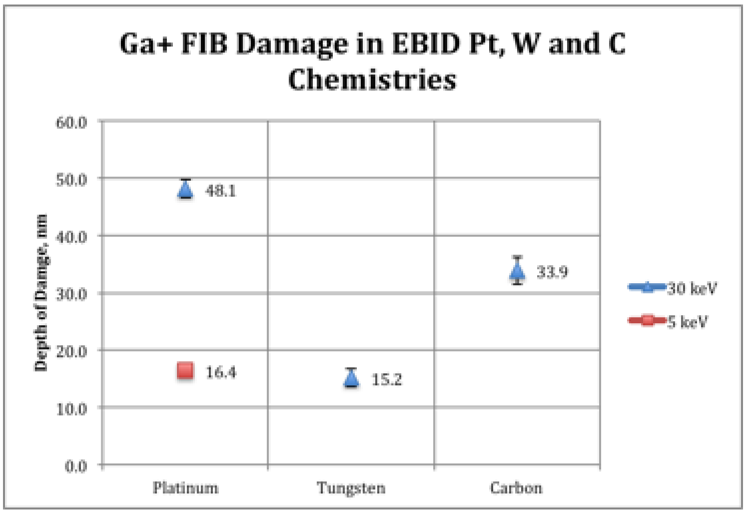

Fig. 3: Average FIB damage depth (nm) during IBID of Pt, W and C over EBID Pt, W and C