An overview of the latest Xe plasma FIB skills

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The main Xe plasma FIB applications to be discussed include large area cross-sectioning, large area TEM sample preparation and IC delayering.

Xe plasma FIB is much more efficient for the production of large area cross sections due to higher available total beam current [1]. However, it is well-known that ion curtaining effects are more prevalent in a plasma FIB due to the inherently lower beam current density. It is also well-known the curtaining effects associated with broad beam ion sources may be mitigated, and cross section quality improved, by rocking the sample while milling from several directions [2]. Applying this method within a plasma FIB system demands a much higher degree of accuracy and precision as compared to a broad beam ion system. The solution must also be user friendly. These challenges have been addressed through a novel high precision Rocking Stage™ [3] developed to greatly improve the surface quality, while keeping the milling process easy and accurate. Greatly improved results were obtained on polycrystalline material samples and on semiconductor samples like solder bumps, packaged ball-bond Au wires and TSVs [3].

Another growing application of plasma FIB sources is production of large area TEM lamellae. TEM lamellae prepared by plasma FIB show much less damage of the lamella surface when compared to Ga beam surface damage produced at the same beam energy [4]. This reduction in amorphous damage depth often allows finishing of the TEM lamella at 30 keV beam energy, without the need of the final polishing step at lower ion beam energy (Fig. 1). It is also possible to combine the Rocking Stage™ technology during TEM sample preparation to optimize the process.

IC delayering is yet another very promising plasma FIB method being explored for the current and future IC technology nodes. It is possible using well defined application recipes to remove plan view sections layer-by-layer down to the finest IC layers, without any intermixing. The Rocking Stage™ again plays an important role by dynamically averaging the ion channeling effects to equalize the milling rate of polycrystalline copper grains.

Figure 1: HR-TEM image of the lamella from IC sample, prepared by Xe plasma FIB at the beam energy 30 keV, showing the high resolution image of the transistor layer.