Expanding the range of the FIB: From rapid material removal to ultra-thin TEM lamella preparation

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Nowadays, TEM sample preparation is routinely done by using focused ion beam (FIB) methods, which, however, are quite often facing two distinct challenges. With today's multi-layer materials, the area of interest is often buried deeply within the sample and requires the removal of large amounts of material in order to access the desired sample structures. Traditionally, this has been achieved by using slow and demanding techniques such as mechanical polishing or cross sectioning and ion polishing or FIB milling.

Secondly, in part due to the renewed interest in low-voltage aberration corrected transmission electron microscopy (TEM), very thin (<20nm) samples are required to obtain excellent high-resolution TEM images. Classical sample preparation techniques like mechanical polishing or ion milling as well as conventional FIB methods cannot be employed to reliably create high quality specimens of the desired thickness from the region of interest.

Carl Zeiss addresses these challenges by combining a pulsed-ns laser with an AURIGA CrossBeam FIB/SEM, which allows for the rapid and precise removal of large amounts of material and the preparation of deeply buried features in a much more efficient way. The ablation of material volumes of the order of $10mm^3$ can be done in minutes, followed by FIB preparation and SEM analysis in the same instrument.

By introducing the newly designed X^2 sample holder, ultrathin (<10nm) TEM lamellae virtually free of preparation artifacts can be obtained by FIB milling. Combined with the SmartEPD (end point detection) software package, the thickness can be precisely monitored during the milling process.