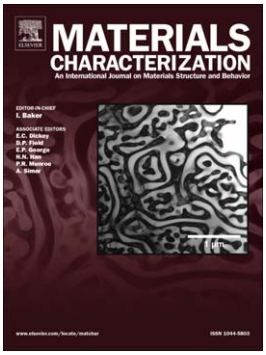

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The TriBeam System: Femtosecond Laser Ablation *in situ* SEM

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Abstract

Femtosecond laser ablation offers the unique ability to remove material at rates that are orders of magnitude faster than existing ion beam technologies with little or no associated damage. By combining ultrafast lasers with state-of-the-art electron microscopy equipment, we have developed a TriBeam system capable of targeted, in-situ tomography providing chemical, structural, and topographical information in three dimensions of near mm^3 sized volumes. The origins, development, physics, current uses, and future potential for the TriBeam system are described in this tutorial review.

Keywords: femtosecond laser, tomography, ablation, serial sectioning, ultrafast laser chemistry

1. Brief History of Development

The development of ultrashort pulse lasers (UPL) in the mid-1980's by Strickland and Mourou [1] ushered in a host of advancements in technologies as wide ranging as spectroscopy, X-ray diffraction, micromachining, tissue modification, femtochemisty, and materials processing [2, 3, 4, 5, 6, 7, 8, 9, 10, 11]. While these new capabilities are applicable across a broad range of materials classes (metals, ceramics, semiconductors, polymers, soft tissues, and composites), to date they have been applied mainly in ambient laboratory environments. Given the rapid, athermal, nm-scale materials modification possible with ultrashort pulses, the *in vacuo* combination of UPL with electron and ion beams, and the microanalytical techniques they enable, promises entirely new frontiers of materials synthesis and characterization. Here we describe the motivation for and development of a new instrument that integrates a femtosecond laser with a scanning electron microscope (SEM) and a focused ion beam (FIB).

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