

# In situ Optical Imaging and Laser Processing in the SEM/FIB: A True EIPBN System

N.A. Roberts\*, J.D. Fowlkes\*\*, P.D. Rack\*,\*\*

*\*Department of Materials Science and Engineering, University of Tennessee*

*\*\*Oak Ridge National Labs, Oak Ridge, TN*

*G.A. Magel, H.M. Marchman, C.D. Hartfield, T.M. Moore  
Omniprobe, Inc., 10410 Miller Rd., Dallas, TX 75238*

Combined scanning electron microscope (SEM) and focused ion beam (FIB) microscopes have dramatically changed the market for process control and failure analysis instruments since their introduction over a decade ago. Integration of optical microscopy and laser processing into these instruments has been minimal. Augmenting SEM/FIB capabilities with true optical microscopy and laser processing at the coincidence point of the ion and electron beams provides an additional contrast mechanism, extends the magnification range and enables laser induced processes.

Figure 1 shows a schematic drawing and a digital photograph of the optical imaging and processing system (OptoProbe™) in an SEM/FIB chamber, as well as a gas injection system. The design of the optical system enables various optical imaging modes (microscopy, fluorescence, scanning cathodoluminescence) as well as laser processing modes, without interfering with normal SEM/FIB imaging and processing modes. The optical system is mounted on a 3-dimensional nanomanipulator so precision alignment and focusing is easily achieved. Examples of images from various imaging modes are illustrated in Fig. 2. Fig. 2 a) (top) is a scanning electron microscope image and complementary cathodoluminescence image of a zircon sample. Fig. 2 b) is a monochromatic fluorescence image of a zebrafish slice labeled with GFP (using 488nm excitation). Fig. 2 c) is an optical image from the OptoProbe™ of a resolution target showing a simultaneously delivered laser spot.

In addition to imaging, the OptoProbe™ can also deliver a high-fluence laser source for laser-induced processing and laser-assisted focused electron and ion beam induced etch and deposition processes. Figure 3 shows a region where silicon has been laser ablated and platinum has been laser deposited (via the MeCpPtMe<sub>3</sub> precursor). In this presentation, we will briefly explain the operation of the various OptoProbe™ modes and discuss in detail recent progress regarding in situ laser processing/secondary electron imaging.

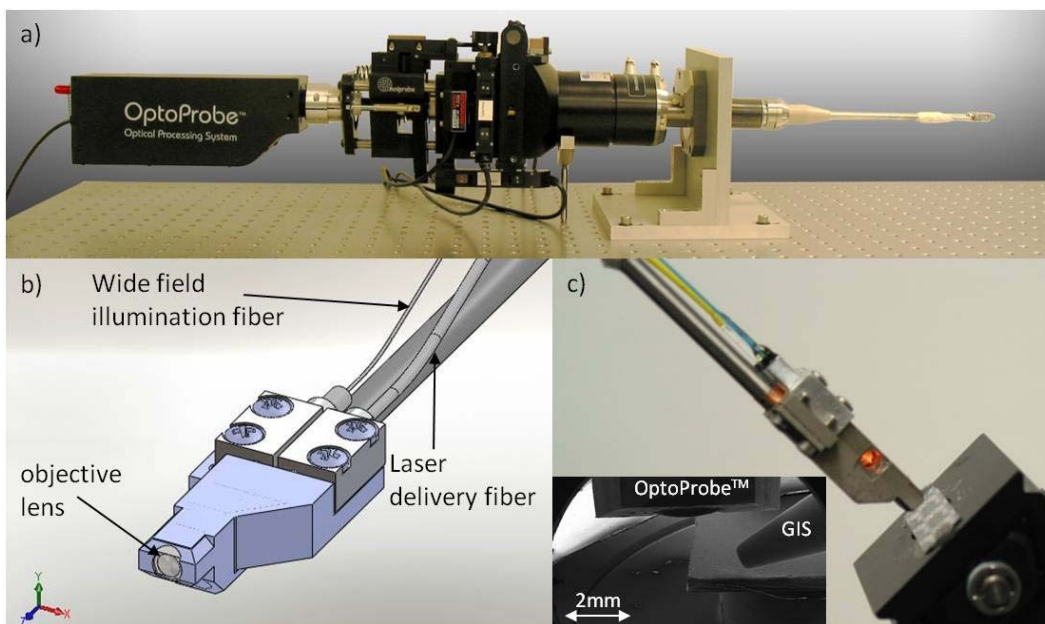


Fig. 1: a) Photograph of the OptoProbe™ system and b) close-up schematic and c) photograph of the head of the system for simultaneous imaging and laser delivery (inset is an infrared image of the optical system coincident with the ion and electron beam and the gas injection system).

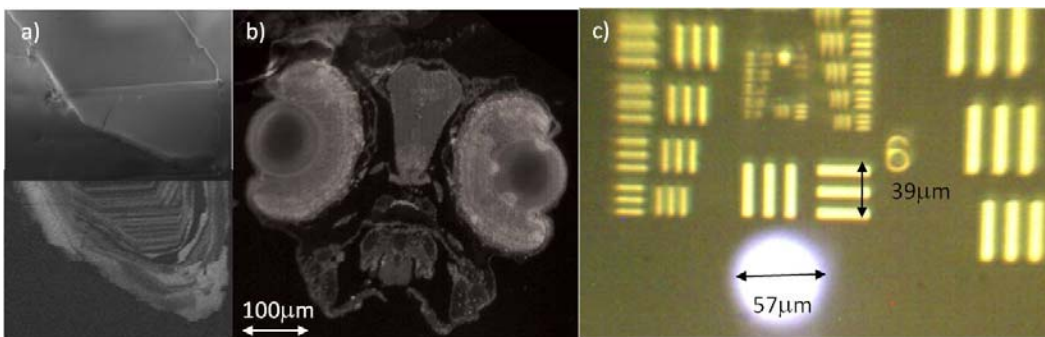


Fig. 2 see text for details. Briefly a) SEM and CL image, b) fluorescence image c) optical image of resolution target and simultaneously delivered laser spot.

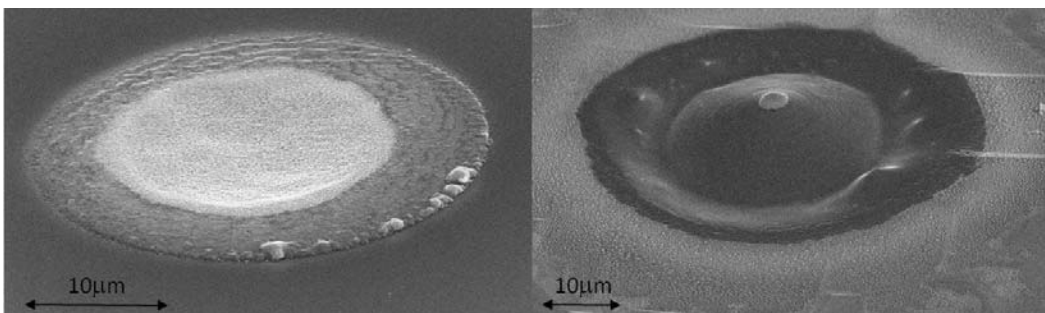


Fig. 3: Scanning electron micrograph of a laser induced platinum deposit and an ablated Ni(20nm)/SiO<sub>2</sub>(100nm)/silicon substrate film stack.