Digital 3D Optical Microscope

The Naval Research Laboratory requires a Digital 3D Optical Microscope to measure sputter craters produced by a SIMS ion source, and to image and characterize the surface of other samples, for both cases without contacting the surface of the specimen.

For quantitative analysis of samples studied with the Cameca SIMS, the depth profile of a sputter crater must be measured with better than 1% precision. The sputter crater depth is usually around 200 nm and has a cross-section area of 100 x 100 μm. Additionally, 3D imaging of the sample surface before and after producing the crater is needed for sample characterization and correct interpretation of data. Similar 3D imaging is required for the surface of a variety of other metallurgical, geological, and electronic materials, where characteristic features such as grain size must be quantified. Some high-value samples do not allow use of a surface contact tool; hence we require an optical instrument.

Digital 3D Optical Microscope Requirements
The system must be able to produce high-resolution 3D non-contact imaging, preferably using LED-light confocal spinning disk multiple pinhole technology. The system must perform well on steep-angle surface features, commonly found on our sample surfaces, and provide rapid image acquisition. Besides quantitative 3D profile and surface data the system must be able to capture microscope images with infinite depth of focus.

A. *Hardware*

1. Motorized XYZ motion control for the XY translation stage and the nanometer-precision Z-axis scanning module
2. Vertical coarse measuring range of at least 75 mm, with 200 nm resolution
3. Vertical fine measuring range of at least 0.25 mm, with better than 10 nm resolution
4. Horizontal motion range of at least 50 mm in x and y, with 300 nm resolution
5. Integrated vibration isolation table or work-stand
6. Fast digital camera with progressive scan technology, and at least 512x512 pixels
7. Computer (with Windows XP Professional), minimum 19” flat-panel monitor, keyboard, and mouse
8. Flatness standard if necessary for instrument to meet expected performance specifications
9. Optional calibration standards for lateral and height measurements
10. Optional vacuum plate
11. Optional color printer
12. Optional table for microscope, if not already included

B. *Optical Properties*
Since optical properties depend strongly on the optical objectives used, a combination of three optical modules should offer:

1. Magnification of 50x, 20x, and 10x
2. Measuring fields between 320x320 and 1600x1600 μm
3. Numerical apertures between 0.8 and 0.3
4. Working distance between 1mm and at least 10 mm

5. Resolution in Z direction of at least 2 nm at 50x
6. Resolution in XY plane of at least 0.7 µm at 50x

An optional higher magnification objective lens will also be considered

C. S*oftware*

A comprehensive graphical software package for acquisition, analysis, manipulation, and visualization should be included and should have the following features:

1. Designed on MS Windows platform
2. User-friendly interface
3. Measurement parameter setting and measurement control
4. Analysis of 2D and 3D parameters and statistics, including sputter crater depth, grain size, surface roughness, and surface topography determination
5. Fast real-time visualization and parameter calculation (or mathematical analysis)
6. Auto-stitch capability allowing for analysis of extended areas by combining basic fields of view, covering up to 6x6 mm field of view
7. Continuously updated
8. Capable of measurement automation
9. Each type of data output available in at least one of several common formats, such as ASCII, jpeg, bmp, pdf, xls.
10. Optional advanced analysis software choices
11. Optional second user license for data analysis software

D. *General*

1. Typical measurement time of about 10 sec or less
2. Long-life light source with at least 50,000 hrs use MTBF
3. Small footprint for instrument
4. Possibility to analyze samples with different surface optical properties (i.e., diffuse or spectral reflectivity), thus allowing for research flexibility
5. Commissioning to include system setup, acceptance-test procedure, and system and software training.
6. Acceptance test must demonstrate that instrument meets declared specifications.
7. Training to include translation of sample, focusing image, adjusting magnification and adjusting image quality (such as contrast, brightness, false color, shading), collecting digital image, and performing quantitative analysis of image for roughness, feature dimensions, and precision of results. Training to be performed for three users at NRL for at least one day, to enable users to readily perform routine operations described above.
8. Maintenance and operational manuals for hardware and all analysis software are to be provided

E. *Preferences*

In evaluating “most advantageous”, NRL will consider the offered system’s interface for ease of use, the speed of visualization and parameter calculation, the capabilities of advanced analysis software, and the size of the instrument footprint.