



## Industrial Inspection

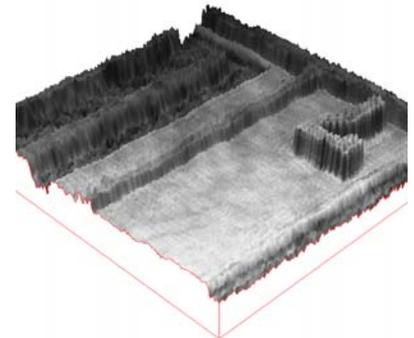
### Digital Holographic Microscopy for Industrial Inspection and Metrology

#### High-Resolution Surface Imaging Using Optical Phase

Researchers at ORNL have developed and patented a direct-to-digital holographic imaging technology and prototype system for the inspection and metrology of surface topology and structure. This method records the complex wave-front of an object directly on the surface of a charge coupled device (CCD) camera in a single digital image. Unlike phase-shifting profilometry methods, the phase and amplitude of the imaged object surface can be determined rapidly from a single digital image at high throughput using side-band (heterodyned) analysis. The phase information is directly proportional to the structural topology (e.g., surface height) and the index of refraction of the various materials composing the surface.

#### Base Technology

The prototype ORNL inspection tool uses a 532-nm laser and can resolve 266-nm in the plane of the object surface while resolving 5-nm to 10-nm in the direction of the surface normal (i.e., approximately  $\lambda/100$ ). The system can detect height differences from pixel-to-pixel on the order of 266-nm (i.e., approximately  $\lambda/2$ ). The prototype tool currently processes approximately 3 frames per second (fps) at 1024x1024 pixels x 12 bits on a standard dual 850-MHz processor Pentium PC (~240Mflops) but could achieve 5 GFlops (15fps) to 10 GFlops (30fps) at 2048x2048 pixels using a dedicated array processing architecture.



*The current system resolves 220-nm in the plane of the surface and 10-nm in the normal direction. Shown is phase image of a semiconductor device.*

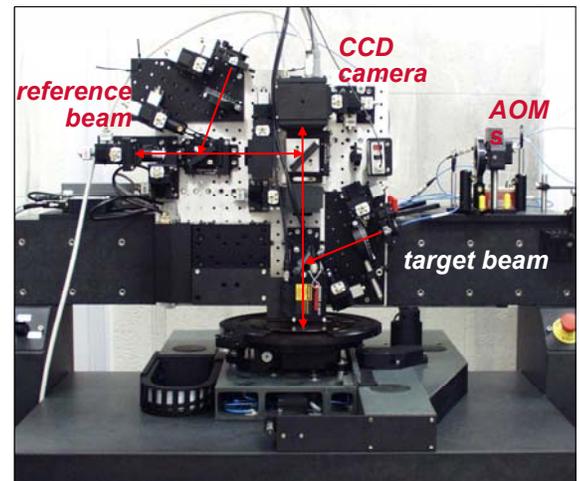
#### Specifications and Features

- Source, 532-nm laser
- Windows OS, Visual C++ software library
- Precision Newport stage (20-nm accuracy)
- Automation software to facilitate large area, referential scans

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*The prototype microscope uses a 532-nm source and is computer controlled to perform automated large area scans and analysis.*