Finding rough spot in surface measurement

July 14 2005

For makers of computers, disk drives and other sophisticated technologies, a guiding principle is the smoother the surfaces of chips and other components, the better these devices and the products, themselves, will function.

So, some manufacturers might be surprised to learn that a fast and increasingly popular method for measuring surface texture can yield misleading results. As reported at recent conferences and in an upcoming issue of Applied Optics,* a team of National Institute of Standards and Technology researchers has found that roughness measurements made with white light interferometric microscopes, introduced in the early 1990s, differed by as much as 80 percent from those obtained with two other surface-profiling methods.

Interferometric microscopes are used to measure surface heights, lengths and spaces by analyzing the interference patterns created by two light beams--one reflected by a reference specimen and the other by the object of interest.

To date, the team has evaluated a total of five white light instruments from three different vendors. They compared roughness measurements of gratings with both wavelike surfaces and random surfaces.

White light interferometers were compared with "phase shifting" interferometers, which use specialized single-color light sources, and with accurate, but sometimes destructive, stylus profiling instruments that trace a sharp probe over a surface. The latter two tools were in

agreement across the spectrum of test samples within the expected measurement range of the phase shift interferometers. For measurements of relatively rough surfaces, white light interferometers also yielded results that corresponded closely. But for measurements of surfaces with an average roughness between 50 and 300 nanometers, results diverged significantly, peaking at about 100 nanometers.

"The discrepancy seems to be unrelated to the specific white light instrument used or to the randomness of the surface profile," explains Ted Vorburger, head of NIST's Surface and Microform Metrology Group.

The comparative study was carried out as part of an effort to develop international standards for three-dimensional measurements of surface texture. NIST researchers are now evaluating theoretical explanations for the observed discrepancies.

* H.G. Rhee, T.V. Vorburger, J.W. Lee and J. Fu, Discrepancies between roughness measurements obtained with phase shifting interferometry and white-light interferometry. Applied Optics, 2005.

Source: NIST