

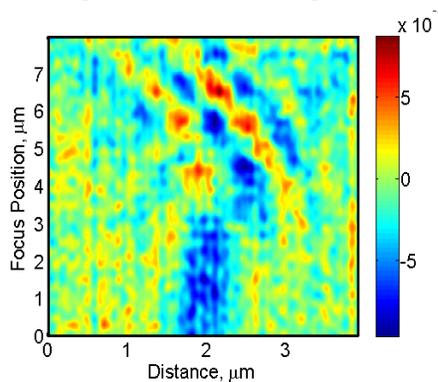
TSOM Method for Nanoelectronics Dimensional Metrology

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Abstract. A relatively new "through-focus scanning optical microscopy" (TSOM-pronounced as "tee-som") method [1-5] transforms conventional optical microscopes to truly 3D metrology tools for nanoscale to microscale dimensional analysis with potentially sub-nanometer scale resolution. The method can be used in both reflection and transmission modes of microscopes. It is applicable to a wide variety of target materials ranging from transparent to opaque, and shapes ranging from simple nanoparticles to complex semiconductor memory structures, including buried structures under transparent films. Potential applications of TSOM include defect analysis, inspection and process control, critical dimension (CD) metrology, photomask metrology, overlay registration metrology, nanoparticle metrology, film thickness metrology, quantum dots, 3D interconnect metrology (large range depth analysis such as TSVs), line-edge roughness measurement, and nanoscale movement of parts, e.g., in MEMS/NEMS [3]. Numerous industries could benefit from the TSOM method —such as the semiconductor industry, MEMS, NEMS, biotechnology, nanomanufacturing, nanometrology, data storage, and photonics. The method is relatively simple and inexpensive, has a high throughput, provides nanoscale sensitivity for 3D measurements and could enable significant savings and yield improvements in nano/microscale metrology and manufacturing. Potential applications are demonstrated using experiments and simulations.

TSOM is not a resolution enhancement method. However, it has a potential to provide lateral and vertical *measurement* sensitivity of less than a nanometer using a conventional optical microscope [3-5], comparable to the dimensional measurement resolution of typical scanning electron microscopes (SEMs) and atomic force microscopes (AFMs) and is expected to extend the limits of optical metrology. The TSOM method has the ability to



decouple vertical, lateral or any other dimensional changes at the nanoscale with little or no ambiguity and has the potential to analyze target dimensions ranging from a few tens of nanometers to relatively large dimensions (tens or even hundreds of micrometers in the lateral and the vertical directions, beyond the reach of typical SEM and AFM) with similar nanometer scale sensitivity. This presentation will describe the method of constructing a TSOM image using a conventional optical microscope along with experimental and simulated results showing nanoscale sensitivity. An experimental measurement with about a nanometer difference in the linewidth of a 45 nm wide Si line on Si substrate is shown on the left (using 546 nm illumination wavelength).

REFERENCES

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