A Safer Way to Make Metal Nanoscale Spheres for Calibrating Surface Inspection Instruments

July 16 2004

Tiny surface defects that form during processing can reduce the quality and yield of semiconductor devices, magnetic storage media, and other products. Inspection tools that locate, identify, and characterize surface defects based upon how they reflect or scatter light need to be calibrated with accurate particle size standards in order to work properly. Making metallic standards for such calibrations is typically a hazardous process, but researchers at the National Institute of Standards and Technology (NIST) and the University of Maryland have invented a safer method and apparatus for producing these standards.

Nanoscale spheres typically are used as size standards for calibrating surface inspection instruments. NIST produces a number of Standard Reference Materials (SRMs) used by the semiconductor industry for calibration purposes, including SRM 1963, which consists of 100 nanometer (nm) polystyrene spheres. The new method produces uniformly sized metal nanospheres, which might be used to determine, for example, whether surface inspection systems can differentiate metal contaminants from other defects.

The new method, patented earlier this year and licensed to MSP Corp., makes spheres 50 nm to 300 nm in diameter out of copper, nickel, cobalt, and other metals. The method involves generating aerosol droplets of a solution in an inert gas, and heating the droplets to form metal particles. The solution contains a metal compound, water, and a solvent such as methanol or ethanol. By contrast, the best of current production technologies use hydrogen gas as the solvent, posing a risk of fire or explosion.

The new method resulted from NIST efforts to develop and validate theoretical models for light scattering by polystyrene spheres. Because it is more difficult to predict light scattering by metal spheres than by polystyrene spheres, scientists validated their theories by making metal particles and measuring how they scattered light. This ensured that the models would be highly accurate for polystyrene. Scientists used metal particles made with the new method to validate their theories under a number of conditions and published several papers on the results. For example, they found that oxides grow on the particles at room temperature and limit their useful life as light scattering standards to only a few months.* This increases the value of having a safer way to generate the particles, because laboratories that use them may need to generate new batches of nanospheres on a regular basis.

** J.H. Kim, S.H. Ehrman, and T.A. Germer, "Influence of particle oxide coating on light scattering by submicron metal particles on silicon wafers," Appl. Phys. Lett. 84, 1278, Feb. 23, 2004.*

Source: www.nist.gov/