Modeling the Sensitivity of Optical Inspection

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Inspection of patterned wafers in semiconductor device manufacturing often requires the detection of defects of sizes F2 where F is the linear size of the smallest feature in the pattern. At present the feature size F is already below 20 nm and expected to reach below 10 nm soon. Operating at wavelengths above 190 nm, inspection tools detect these deeply sub-wavelength scatterers in partially or completely unresolved patterns. The signal from defects of interest is detected against a large complex background of wafernoise arising from the scattering of light from interfacial roughness and critical dimension (CD) variation of the printed features. Separating the signal from this intrinsic noise from the wafer is the key challenge in maintaining relevance of optical inspection as the feature scaling continues. Physics-based modeling of the light-matter interactions in the wafer, coupled with modeling of the image formation, has been playing an important role in developing sensitivity solutions in optical inspection. In this presentation, we will discuss simulation techniques to perform large-scale studies for statistical estimates of sensitivity. We will discuss the applications of these methods in understanding and resolving sensitivity challenges, assess novel imaging technologies, and applications to wavefront specification for the next generation projection optics.