On a Technique for Measurement System Analysis of Defect Metrology

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Countless decisions about process and equipment evaluation, control, and improvement are made every day in every semiconductor manufacturing fab. For these decisions to be sound and rational, the measurement systems for obtaining the necessary data must be accurate, precise, and stable over time. Significant biases and variability in the measurement process - whether due to the metrology equipment itself or the procedures utilized for obtaining the measurements - adversely affect the conclusions and actions that are undertaken based upon the observed data. All data-based decisions are dependent on the measurement systems that generate the data.

Measurement System Analyses (MSA's) are statistically-designed experiments intended to identify, quantify, and reduce major sources of bias and variability in the measurement process. Some stated goals of MSA's are to estimate components of measurement error, estimate the contribution of measurement error to the total variability of a process or equipment parameter, determine stability of a metrology tool over time, and to compare and correlate multiple metrology tools.

The ability to detect yield-limiting defects on specific process layers close to the defect's source is the primary requirement of a Defect Metrology tool. Extending this ability to the diverse throughput requirements for yield learning and improvement in various phases of production creates several extremely complex problems. In addition, the high purchase price of defect metrology equipment encourages manufacturers to run different products in multiple stages of process maturity through the same defect detection tools to extract maximum returns from the extensive capital investment in such tools. Now more than ever, these Defect Metrology tools must be accurate, precise, sensitive, stable, and fast.

However, classical Measurement System Analysis techniques are particularly poorly suited for application on Defect Metrology tools. There are no standards for defects. Defect morphologies change over time with varying product detectabilities. The physical process of counting defects complicates the statistics used for analysis. Comparisons of performance between the same or different types of defect metrology tools are daunting. The idea of Tolerance is difficult to define for Defect Metrology. These and many other problems have been recognized for years, and several techniques have been proposed to deal with them, with limited success.

This presentation will describe the development and deployment of an experimental technique for conducting and analyzing Measurement Systems Analyses for Defect Metrology tools. This technique will be compared and contrasted to some existing techniques, and will be judged relative to the objectives of a classical MSA and to the applicability objectives of High Volume Manufacturing.