TEA Systems Corp.
65 Schlossburg ST.
Alburtis, PA 18011
(610) 682 - 4146

June 6, 2002

Process Window Interface Overview

Analysis and control of the process requires more than knowing a single focus and exposure-dose value. Proper specification requires the user to understand the variations in exposure caused by the exposure tool and the portion of these components contributed by the metrology. Similar to the aberrations associated with overlay – positional distortion, an exposure tool exhibits a unique signature of feature dimensions that vary across the lens, slit and across wafer. Variations are caused by focus offsets, local variation in exposure dose, NA, sigma and mechanical scanning.

Any type of data can be analyzed in this section but most often the data is either Critical Dimension or film thickness. The software has four sections that allow the user to select "windows' of the data and optimize the analysis to discriminate between lens, metrology and process variations. The four interfaces are:

Precision

Precision values allow the user to examine behavior of the metrology and exposure tools without data modeling. The operate using the currently selected data subset, and increase in accuracy as the number of data points increase in number. Values shown in the software, see the figure below, reflect the one-sigma – standard error – of the calculate variance.

Sigma is defined as the square root of variance of the data.

The **Variance** is the sum-of-squares of the data population's variation from the mean of the population divided by the degrees-of-freedom (dof) of the data.

Note that the precision values shown below will not appear forall data sets. For example, the wafer precision will not be calculated if the dataset has only one lot worth of data in it.

Precision Values Computed

SS = Sum of Squares of difference of each measurement from the mean of the group.

Note that the SS measurement is influenced by the grouping of the data.

Constants:

n = Total # measurements

m = Total # die

Precision Calculated	Requirement & Explanation	Variance	dof
Pure Error	Represents the static or dynamic measurement precision of a single data point. Requires: Multiple measurements of a single site.	SS_{point}/dof_{pe}	Dof_{pe} = #measurements of single point -1
Site Precision	The variance of values for each unique site on the exposure field. Requires: Multiple die with same site location.	$(SS_{site} - SS_{pe})/Dof_{sp}$	dof_{sp} = n - #sites
Row Precision	The variation of values within a single exposure row. On a scanner, this represents the variation in features across the lens slit. Loss of precision will result from lens aberrations and variation in exposure. Requires: Multiple sites in a single row on a die, multiple die	SS_{row} / Dof_{row}	Dof_{row} = n - #Rows
IntraRow	Variation seen from row-to-row or, in the case of a scanner, from slit to slit.	$(SS_{field} – SS_{row})$ / $DoF_{IntraRow}$	$DoF_{IntraRow}$ = #rows - #fields
Column Precision	Column precision is the variation of data across the columns of the field. For a scanner, these variation are caused by errors in the reticle and/or stage scanning mechanics. Requires: Multiple sites in a single column on a die Variation seen across the column	SScolumn / Dofcol	Dof_{col} = n - #Columns
IntraColumn	Variation seen from column-to-column	$(SS_{field} – SS_{column})/DoF_{Intracolumn}$	$DoF_{Intracolumn}$ = #columns -#fields

Precision Calculated	Requirement & Explanation	Variance	dof
Field Precision	Variation by field. Requires: Multiple Fields.	SS_{field} / Dof_{field}	Dof_{field} = #Fields-1
Field Grid	Variation by position on the wafer grid. Requires multiple wafers.	SS_{grid} / DoF_{grid}	DoF_{grid} = #fields – #Fields/wafer
IntraField Precision	Variation of measurements within a field excluding the site measurement variation. Requires: Multiple wafers and multiple sites.	(SS_{Field} – SS_{site}) / $Dof_{IntraField}$	$Dof_{IntraField}$ = #sites - #fields
InterField Precision	Variation field-to-field. Requires: Multiple fields	(SS_{wafer} - SS_{field}) / $Dof_{InterField}$	$Dof_{InterField}$ = #fields - #wafers
Wafer Precision	Requires: Multiple wafers. Variation within each wafer	SS_{wafer} / Dof_{wafer}	Dof_{wafer} = n - #wafers
Inter-Wafer	Stage stepping errors. Requires: Multiple wafer. Wafer-to-wafer variation	(SS_{total} – SS_{wafer}) / Dof_{IW}	Dof_{IW} = n – (pts/wafer)
Lot Precision	Overall precision of the lot. Equivalent to taking the standard deviation of the entire data set.	SS_{total} / n	Dof = n