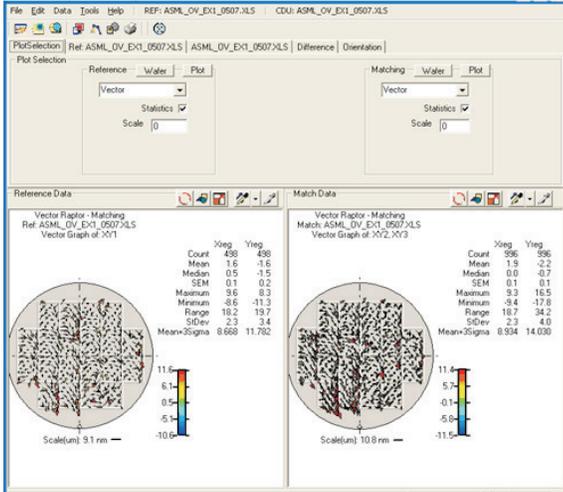**TEA Systems Corporation**

VR Matching

Matching and Difference Analysis Tools

Easily analyze process response using <u>Side-by-Side Comparison</u> of process response graphics as well as <u>Difference/Subtraction</u> of any characterization or performance data.

2-D Vector graphics display with graph selection tab for a reference wafer and matched to two other wafers in the lot

Applications

- Critical Dimension (CD) control issues in lithography and etch, as well as film thickness, CD, erosion, and microstructure control in CVD, CMP, ALD, and Epi process modules.

- Ultra-fine improvements of Process Window performance including extrapolation of design rule capabilities and evaluation of robust device response.

- Focus uniformity and lens-slit-reticle response optimization as well as process centering is easily analyzed using vendor-specific focus or derived data.

- Performance matching of Exposure Tool, CMP, Etch and all pattern generation toolsets is easily performed for one, two or more tools.

- Double-patterning uniformity optimization, process centering and reticle-evaluation is easily analyzed with unprecedented sensitivity to systematic process and tool signature extraction.

- Rapid and simple detection of the onset of reticle haze and lens contamination as well as heating and flare induced process variation.

Data Types

Any format data can be compared & subtracted for a Difference Analysis. Data DOES NOT have to be from the same recipe, location, field or wafer layout

All forms of metrology data are supported whether it be overlay, registration, Critical Dimension (CD), film thickness, feature-profile, capacitance, time dependant, focus, FOCAL, tool logs, process logs or thermal.

Data can be automatically imported into the TEA Systems Standard Data Format that is stored in Microsoft Excel Workbooks. Each workbook stores the raw data, layout, and alignment header information. As a dataset is analyzed, the reports, statistics and summary modeled data is stored on worksheets in the workbook creating a natural working log of the data. An Index worksheet is automatically created during analysis providing automated summary, time/date stamps and an easy link to the reports.

Data can also be manually entered into the data workbook by following the format specifications published by TEA Systems.

All Workbooks are open format and can be easily accessed by other applications such as Microsoft Excel and MathCAD.

Automated data import is guaranteed by TEA Systems and there is never a charge for new data formats added to the import library.

Market Needs

Comparative analysis of process data is a complex and error prone task. Historically overlay matching provided the classic challenge example for tool matching. In the fine performance adjustments needed for advanced process setup or control during today's development of double-patterning techniques or enhanced-performance reticles, the size of the data set, simple layout differences, subtle changes from the process and small errors in metrology all contribute to hide the critical details needed for optimization.

Classic process window models have grown more complex in an attempt to emulate the increased complexity of the process while still missing subtle performance that can strongly influence device yield in production.

When a correction is added to a tool or recipe segment the response of the resulting process is often very different form the control input because of the subtle response errors of vendor models or neglected control factors in the calculation. Observing the presence of and understanding the actual correction received by the process is impossible without difference calculations.

TEASystems

Right Side - Data Tuning

Tools for Data Tuning, figure to the right, provide accurate removal of poor metrology, soft metrology errors. Data can be restricted to individual features or feature-types called "Family" groups. Family Groups are useful for looking at design variations of the same feature such as alignment mark designs, OPC, proximity and double-patterning assists.

Data Culling can be manually performed using the interactive mouse graphics or by restricting the range of the selected variable.

Below - Process Window Comparison

This trend plot illustrates the use of VR Matching to compare the Bottom CD mean size and range across the process window. Five Bottom Anti-Reflective Coatings with an 80 nm +/- 10% process window are compared.
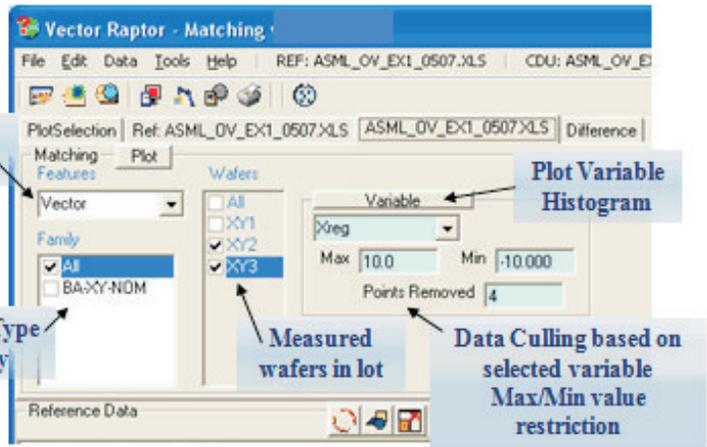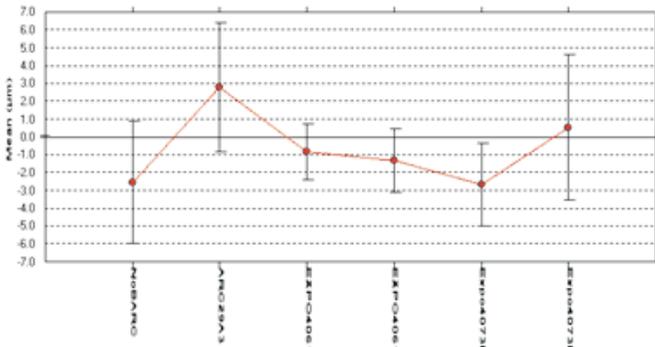

Recommended Platform

The VR Matching® software suite runs on Windows 2000, XP, Windows Server 2003 etc. A 1.4 GHz, Dual-Channel CPU minimum is suggested for larger data sets as well as video display of 1024 x 768. Microsoft Excel® spreadsheet software is required for data storage an can be purchased through TEA Systems.

Left Side - BCD deFocus Difference Mapping

BCD variation after the Average-Field BCD Signature for zero-defocus is removed from the data. Sites shown exhibit BCD variation for +0.01 and -0.01 um defocus of the scanner for a 64 nm feature.
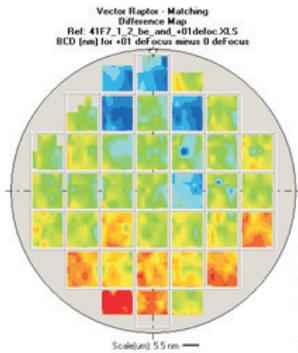
Right Side - BARC Process Window

Focus (Vertical) and Dose (Horizontal) process windows for 80 nm SEM measured BCD data. Results are shown as comparison between two manufacturer's BARC films.
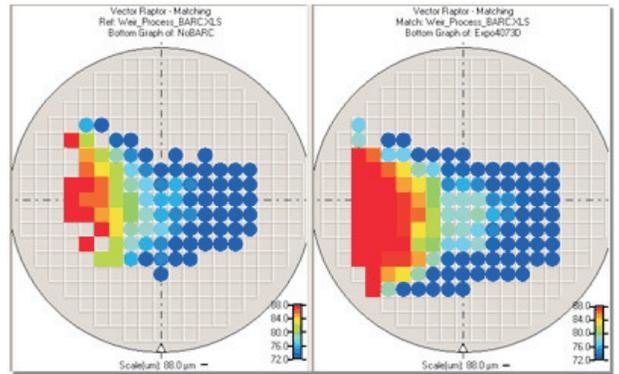
VR Matching Solution Provided

VR Matching allows reference and match data segments to be compared side-by-side. Easily accessed tools provide multi-level data error removal as well as user-selected segmentation of the data. Graphics, statistics and reports for histograms, vector, contour and multiple variable X-Y graphics across the wafer, field, slit and scan response regions as well as radial process responses are easily generated with a single click of the mouse. Multiple wafer data sets provide both summary compound maps as well as individual response graphs for each wafer without the need for additional effort on the part of the user.

VR Difference Matching allows any standard or data segment to be removed from a matched dataset. Advanced interpolation methods along with proprietary techniques for poor metrology data-culling provide unprecedented resolution of the true response of the process or tool. Reference and match data do not have to be the same feature, site-location or recipe setup for data difference monitors.

Evaluation of the process response across a focus-dose matrix along with data range segmentation provide a unique tool for the optimal comparison of process window response for any format CD, film-thickness, electrical response or overlay data. Process response is not restricted to the averaging effects and limited performance of classic Process Window programming.

Any format metrology data can be imported automatically or manually entered. Data is converted into the TEA Systems Weir Standard Format and stored in the user-friendly and open structure of a Microsoft Excel Workbook. Weir workbook data can be easily re-loaded into any TEA Systems product or user-designed application. Each workbook is an analysis environment supporting automated index generation for easy access of data, setup and report worksheets specific for each analysis project.