

LithoWorks PEB

Post Exposure Bake - process optimization of features

Software suite for enhanced Hot-plate/Chill-plate and Feature Profile uniformity.

Input

- ▶ Any film or feature metrology data
- ▶ CD-sem metrology, overlay, scatterometry, Ellipsometry
- ▶ Process simulator outputs
- ▶ Thermal-sensor data from any data source

Storage

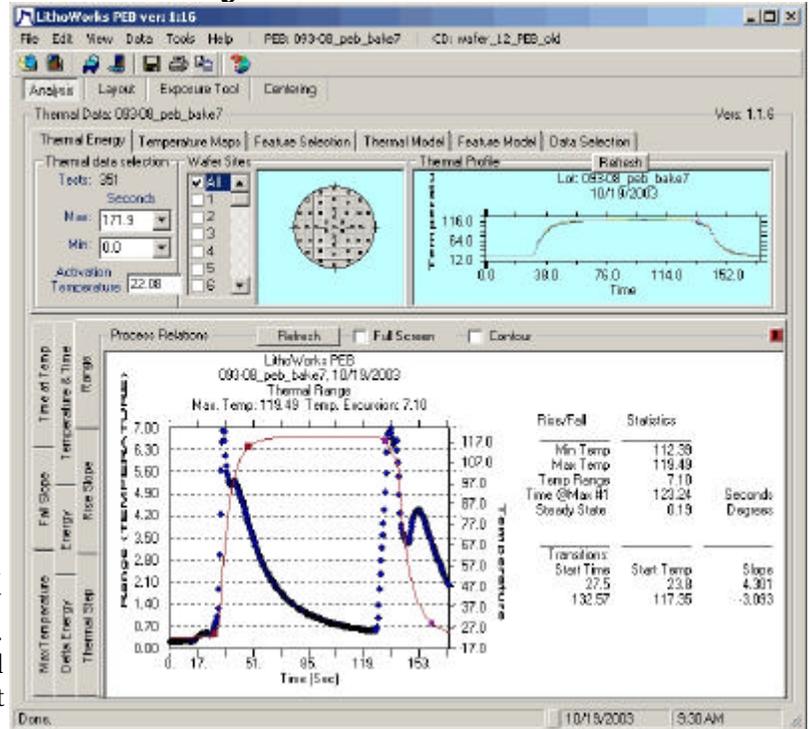
- ▶ Microsoft Excel™ Spreadsheets and workbooks
- ▶ Open system; access to all raw, calculated and modeled data.

Applications

- ▶ Thermal process optimization and characterization
- ▶ Hotplate/chillplatematching
- ▶ Process development
- ▶ Simulation variable validation and calculation
- ▶ Simulation results validation

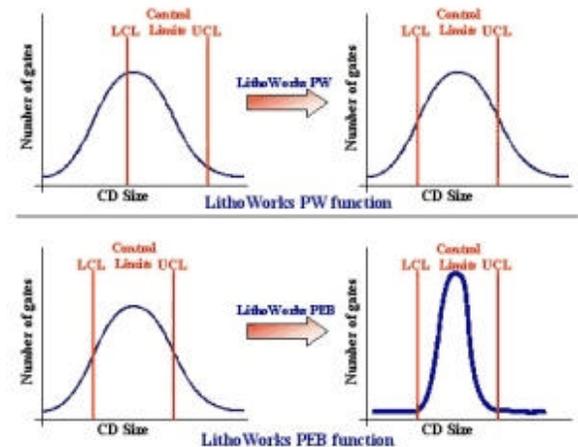
Dimensional spreads across the wafer during each lithographic imaging step are most strongly controlled by the speed and uniformity of the post-exposure bake (PEB). During the PEB a thermal dose is delivered to latent acid image of the exposure to drive the deblocking reaction that changes the solubility of the resist in the develop step.

Device critical geometries are rapidly approaching 40 nanometer (nm) node with tolerances of about 2 nm, 3 sigma variation about the feature size. Since the sensitivity of deep ultraviolet (DUV) resists to temperature variation during the PEB range around 3 nm/°C, it is critically important that uniformity of the bake cycle be closely characterized, controlled and monitored during production. **LithoWorks PEB™** provides tools to characterize, model and control the uniformity of critical feature dimensional variation arising from the PEB process step. LithoWorks PEB is capable of gathering data from any thermal mapping product including the OnWafer and SensArray temperature monitors. Critical dimension (CD) data are gathered from measurements taken by many commercial sources including CD-SEM's, Scatterometry, Ellipsometric and Electrical Linewidth Measurement (ELM) tools. Thermal and CD data are then convolved using models and SLS proprietary analyses to characterize the PEB cycle and set its control variables to minimize variations across the wafer.



Above: LithoWorks PEB

Average Temperature profile and range across wafer at any point in the bake cycle



Top: Process Window analyses center the production process within the design control-limits of the process

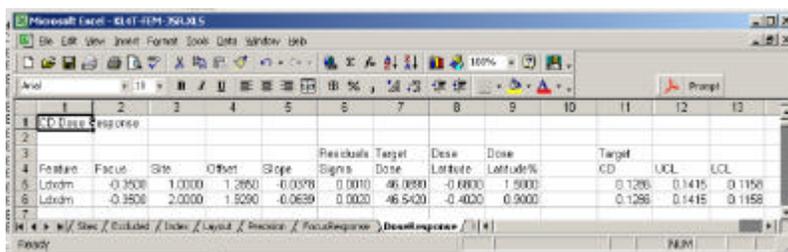
Bottom: LithoWorks PEB improves the distribution of high-performance devices within the process.



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Right:

Spreadsheet storage & model study of Side-Wall Angle variation with feature packing.



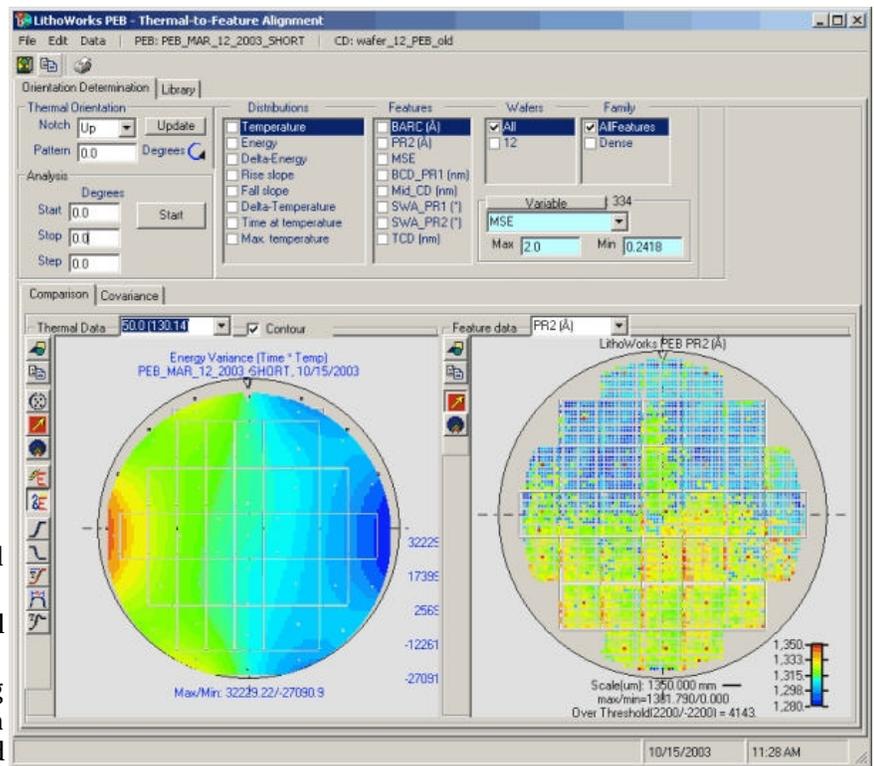
Perspective

LithoWorks PEB® is used to minimize process variation of critical dimensions within the process window.

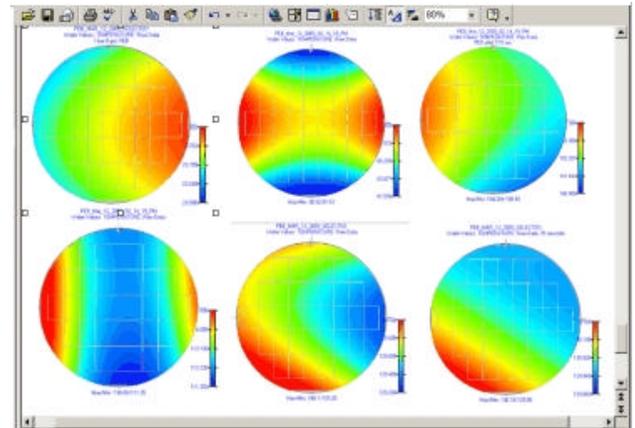
The LithoWorks suite provides an open system of access and versatility for the process engineer. Any form of metrology data can be easily imported. Data, analyses and results are all conveniently stored in Microsoft Excel® workbooks for easy access and customization. Analyses are conducted using the unique object-oriented lot models and interactive graphics of SLS Inc.

Features

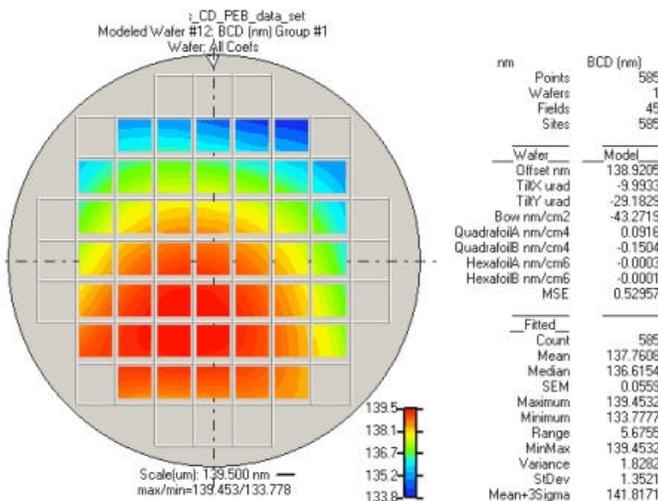
- ▶ Automatically converts any data into Excel Spreadsheets.
- ▶ Adaptive models, raw data and residual spatial analysis interface.
- ▶ Analyze the entire bake cycle including Temperature, rise/fall times, variation mapping, time-at-temperature, integrated energy and integrated energy variation across the plate.
- ▶ Model wafer dependant variations of films and feature profiles.
- ▶ Automated orientation calculation for BakePlate-to-Exposure-Tool alignment.
- ▶ Automated exposure layout and tool configuration with the Weir layout interface.
- ▶ Exposure tool library for storage of tool characteristics.
- ▶ Object-oriented structure with point-and-click graphics and culling.
- ▶ Advanced graphics include histograms, vector, range, XYplot, BoxPlots, Population Density, contour, bulls-eye and 3D plotting.
- ▶ Easy sub-set data selection; automated and manual
- ▶ Data culling ... automated by wafer, field, site, range, NA, PC (Sigma) and manual mouse-selection.
- ▶ Full wafer models with coefficient removal and simulator for "What If?" scenario investigations.
- ▶ Thermal variable to film/feature distribution correlation and covariance matrices.



Above: Analysis orientation and feature covariance



Above: Thermal cycle contour gallery. Galleries can also be viewed as interactive movies.



Above: Modeled BCD variation across the wafer.

System Recommendations

LithoWorks PEB? is a compiled application with a full object oriented, mouse-interactive interface. Drill down graphics and spreadsheet analysis supported. Functional on Windows NT and Windows 2000, XP etc.. Microsoft Excel? is required.

Recommended hardware:

- ▶ Pentium IV, 2.0 GHz, 512 Meg of RAM, 1024x768 Graphic Monitor and 30 M free space on disk for programs. Data storage may require up to 2.0 Gigabytes additional.

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