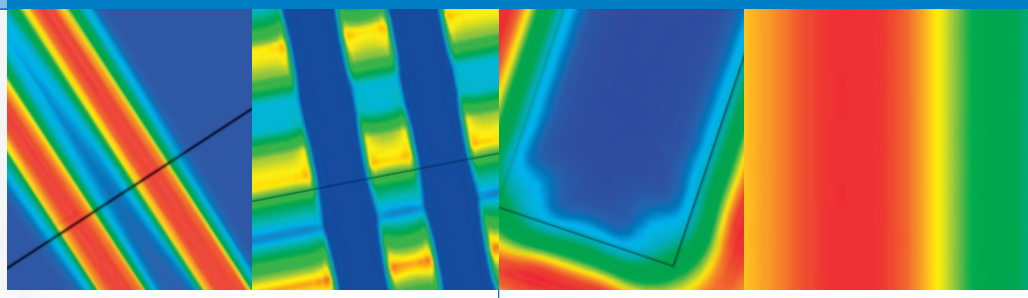
LAB



All in One Lithography Simulation

Enable next generation products and faster development by computational design and process optimization

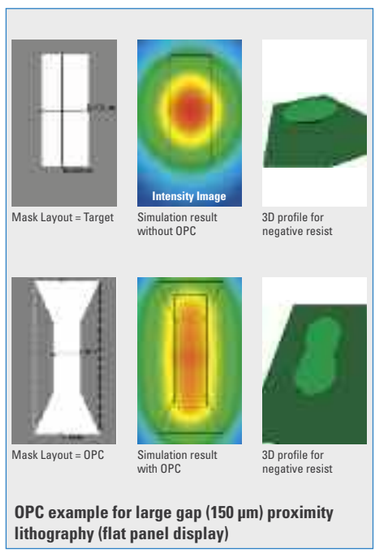
GenISys

Advancing the Standard

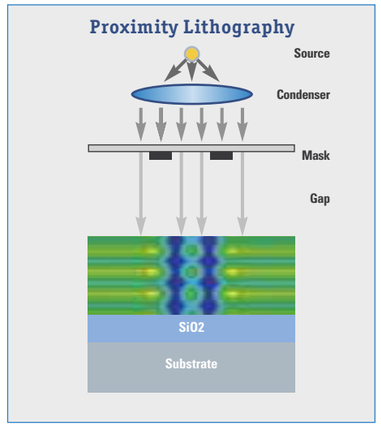
LAB

Layout and process optimization platform for most common lithography technologies

Experimental layout optimization and process development is highly time consuming and thereby expensive. Lithography simulation enables virtual exploration of a huge parameter space very quickly. **LAB** enables further miniaturization for **proximity, projection, laser and electron beam lithography** in one platform for applications such as IC manufacturing, flat panel display, LED, MEMS, 3D packaging, mask manufacturing and nano-fabrication. The fast and accurate calculation of the intensity image enables layout optimization (OPC), mask layout verification, optimization of process conditions (e.g. illumination, stack) and process window (e.g. gap or defocus and exposure dose variation) by varying the layout and/or exposure parameters. Thousands of experiments can be computed "overnight" without producing masks or "burning" wafers. Once a good image contrast has been obtained, 3D resist development modeling allows further optimization of the resist profiles. Complex process effects such as lateral development, density dependent bias in e-beam or in laser lithography can be analyzed and compensated.



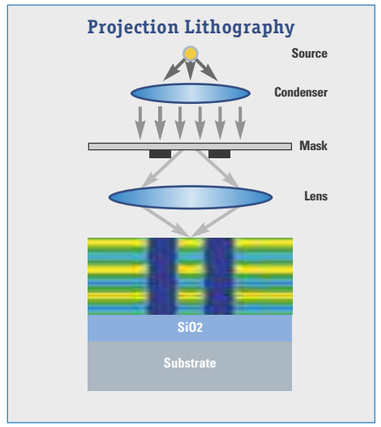
OPC example for large gap (150 µm) proximity lithography (flat panel display)



Proximity Lithography

The intensity at arbitrary distances from the mask (from contact to large gap) is computed using the Rayleigh Sommerfeld approximation, which takes into account all the diffraction orders scattered from the mask. Image propagation in the resist (including all reflections from the stack) is computed using the highly accurate Transfer-matrix method (TMM).

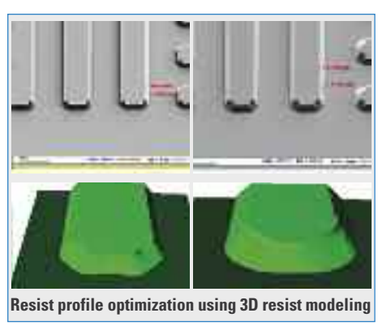
- Models reflective and refractive **proximity lithography**, e.g. large area proximity-printer, mask aligner, contact printer
- Any type of source with arbitrary spectrum and shape , e.g. broadband mercury lamp, laser, collimation angle and user defined source shapes
- Support for SÜSS MO Exposure Optics®, enabling source shape and source-mask optimization
- Binary, gray-tone, or phase shift masks
- Any substrate material, coating, resist, topography
- Thick resist and resist bleaching



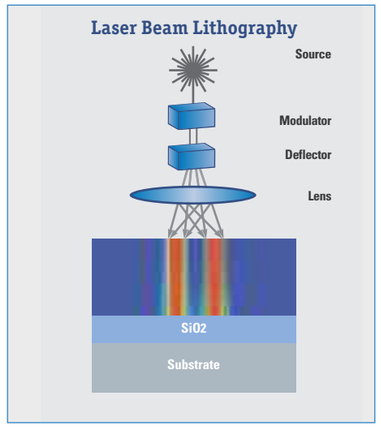
Projection Lithography

The intensities are computed based on Fraunhofer diffraction theory solving the Hopkins equation, followed by propagation in the resist (including all reflections within the stack) using the highly accurate Transfer-matrix method (TMM).

- Models reflective and refractive projection lithography, e.g. large area projection-printer, scanner, stepper including high NA and liquid immersion
- Any type of source, either laser source (single wavelength) or arbitrary Spectrum (e.g. broadband mercury lamp), with any shape (e.g. circular, annular, or user defined source shapes), source polarization
- Binary, gray-tone, or phase shift masks
- Any substrate material, coating, resist
- Thick resist and resist bleaching



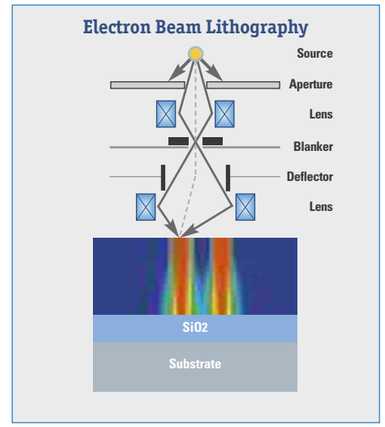
Resist profile optimization using 3D resist modeling



Laser Lithography

The intensities in the resist are calculated by incoherent superposition of the partially coherent beam (with parameters λ, numerical aperture (NA), beam size on wafer or beam radius and focal length of the tool optics).

- Models all major exposure tools for mask or wafer exposure
- Includes the illumination optics of HIMT exposure tools
- Simulates gray-tone lithography
- Any substrate material, coating, resist
- Thick resist and resist bleaching



Electron Beam Lithography

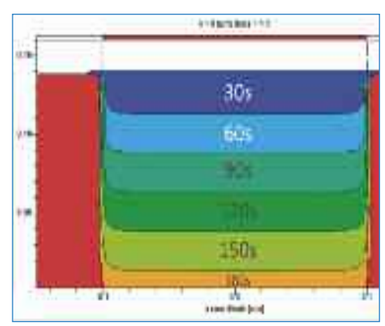
The intensities in the resist are computed using a 3D point-spread-function (PSF) that describes the stack dependent spread of the energy.

- Models Gaussian as well as shaped beam tools
- Interfaces to various 3D Monte-Carlo PSF packages or a user defined Multi-Gaussian PSF
- Simulation of dose modulated layouts (3D lithography, proximity effect correction)
- Simulation of user defined regions in large layouts

Resist Modeling

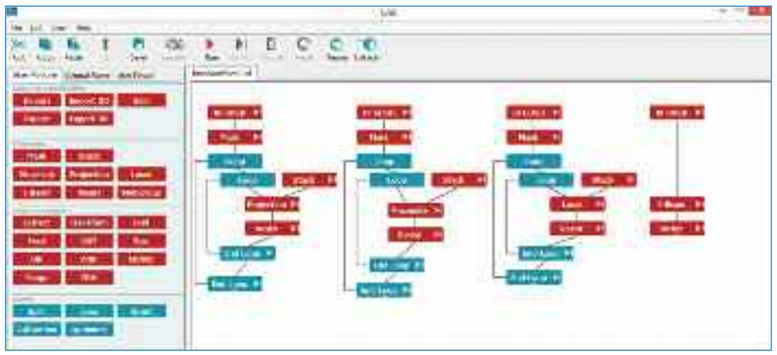
For all lithography methods, **LAB** also offers the simulation of the resist development process using sophisticated and proven models such as Mack4, Percolation, CAR models, or simple diffused image and threshold modeling.

LAB has all the tools to calibrate resist models to experimental data (e.g. contrast curve, CD measurements, or resist profiles). Material and resist parameters are managed in a database that can be modified by the user.



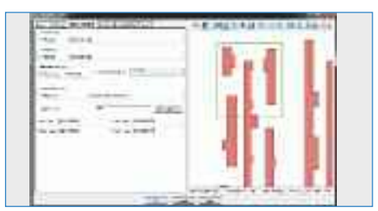
LAB

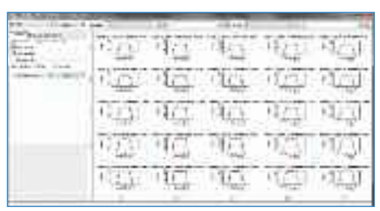
LAB
the most powerful lithography simulation tool kit

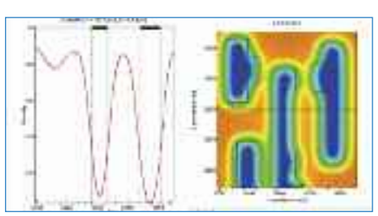


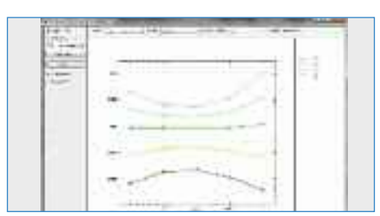
The VisualFLOW™ user interface allows easy and intuitive design of flows with simple drag and drop of functional modules, providing increased productivity and efficiency. A comprehensive library of modules is readily available to visually design flows that can be easily stored in user defined databases for management and reuse. This simple yet highly functional approach empowers the user to concentrate on the essential simulation tasks. To get a quick first impression of the application behavior, the process modules are snapped together, and the essential lithography parameters are defined. Results can be evaluated by powerful visualization capabilities, including 1D, 2D and 3D views. The combination of 1D and 2D views and the capability of arbitrary cut-lines along with image quality metrics such as slope and log-slope allows a very detailed analysis. Dimensions (CD) can be measured either manually within the various views or automated through the metrology module. Optimization of the mask layout can be performed easily either manually through the integrated Layout Editor or semi-automated through powerful layout operations (Extract, Bias, Boolean…).

LAB combines accurate simulation with strong tools for automated analysis (loop and optimize for varying parameters), metrology (measurement of dimensions) and evaluation (1D, 2D, 3D visualization, Matrix view, Process-Window,…).









LAB Major Features

Layout Operations
- Import Export of all major layout formats (GDSII, OASIS, CIF, DXF)
- Loading full layout data
- Extraction (Region, Layer, Cell), Transformation (Scale, Shift, Mirror, Rotate)
- Heal, Bias, Boolean operations, Merge

Layout Editor
- Creation of new layouts
- Layout modification within flows for manual OPC

Mask Definition
- Arbitrary layouts, regions of large mask data
- Gray-tone mask
- Phase shift mask

Stack Definition
- Any substrate and coating material with wavelength specific n/k parameters from material database
- Resist with wavelength dependent n/k, bleaching, Dill and development parameter (Mack4, CAR, Percolation, Threshold)
- 3D Topography (optional)

Proximity Exposure
- Source spectrum (single line, broadband, peak-width)
- Source shape (circular with collimation angle, user defined, SÜSS exposure optics),
- Mask/Illumination tilt in X and Y
- Fast and accurate simulation of 2D or 3D intensities based on Rayleigh-Sommerfeld and Transfer-matrix method (TMM)
- Arbitrary gap from contact to large distance

Projection Exposure
- Source spectrum (single line, broad band, peak-width)
- Source shape (circular, standard shapes of major stepper tools, user defined)
- Fast and accurate simulation of 2D or 3D intensities based on Fraunhofer diffraction solving the Hopkins equation and Transfer-matrix method (TMM)
- Projection aligner, scanner, stepper of any NA including liquid immersion

Laser Beam Exposure
- Models any major laser tools for mask or wafer exposure
- Includes the illumination optics of HIMT exposure tools
- Simulates gray-tone lithography

Electron Beam Exposure
- Models Gaussian as well as shaped beam tools
- Interfaces to various 3D Monte-Carlo PSF packages, or user defined Multi-Gaussian PSF
- Simulation of dose modulated layouts (3D lithography, proximity effect correction)

Resist Development
- Simple and fast threshold and diffused aerial image model
- Mack4 for positive and inverse Mack negative resist development model
- CAR with dynamic Acid / Quencher diffusion / reaction model
- Percolation resist development model
- Surface inhibition for Mack4 and Percolation model
- Extract 2D resist contours as layout data

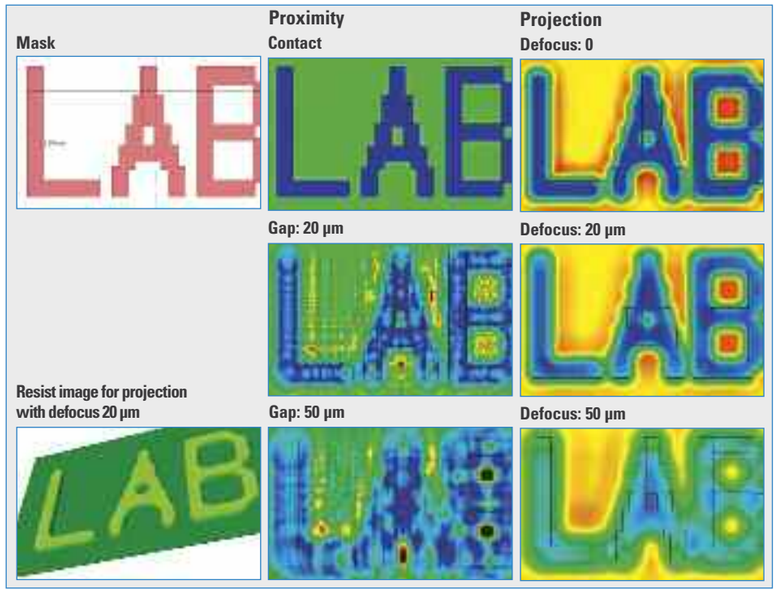
Metrology - Calibration - Optimizer
- Automated measurement at multiple metrology positions
- CD measurements at user defined resist height, or remaining resist thickness measurements
- Measurements can be collected for viewing in trend graphs (FE matrix, PW graph)
- Calibration of resist parameters with experimental data (contrast curves, FE matrix, arbitrary metrology data)
- Flow parameters can be optimized to match a specified target using the Optimizer module

Visualization
- 2D visualization of aerial image, bulk image, Photo-Active-Compound (PAC) concentration, resist profile
- 2D views in continuous color mode, or discrete contour lines at user defined thresholds
- Arbitrary cut-lines in 2D views, 1D view along these cut-lines
- Combination of 1D and 2D views next to each other
- Overlay mask and/or target layout in 1D and 2D views
- 2D Matrix views, 1D Matrix or Overlay view
- Analysis of image quality: intensity, image slope, image log-slope
- 3D visualization of resist profiles
- View of collected metrology results as graph, e.g. FE Matrix (smile plot), process window

Import 3D - Export 3D
- Save and load 3D simulation data (image intensities, concentration)
- CSV Export

LAB

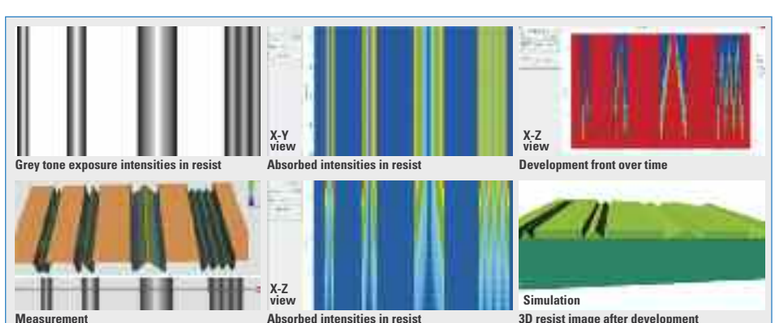
Pushing the limits



Projection lithography simulation has been a key enabler for IC manufacturing to keep track with market demands and Moore's law. Although 30 years ago the end of optical lithography was predicted for feature sizes < 1µm, optical lithography is currently doing < 30nm today in volume manufacturing. Without lithography simulation and the simulation based resolution enhancement techniques such as OPC, source shaping and source mask optimization these dimensions would never have been possible.

LAB offers the power of simulation to push the limits for IC and non-IC applications (display, LED, MEMS, special devices) with the strength of GenISys providing flexible packaging and licensing, fast development of needed functions, highly dedicated application support and a strong co-operation with users.

LAB combines the major lithography techniques used today (projection, proximity, laser, electron-beam) on a single simulation platform. This enables users to compare and to develop mix and match processes.



3D laser lithography (grey-tone exposure) simulation for a HIMT exposure system

LAB – Packaging

LABkit is a comprehensive simulation package combining multiple lithography methods with layout operations and the power and flexibility of VisualFLOW™. The tool kit allows fast and easy simulations with access to all parameters, or semi-automated verification and optimization, or fully automated simulation tasks using Python scripting.

LABpro is a comprehensive package for production environment offering multiple simulation modules (e.g. projection and proximity), multiple simultaneous users, larger number of cores for parallel processing, plus additional layout processing functions.

Extensive Tool and File Format Support

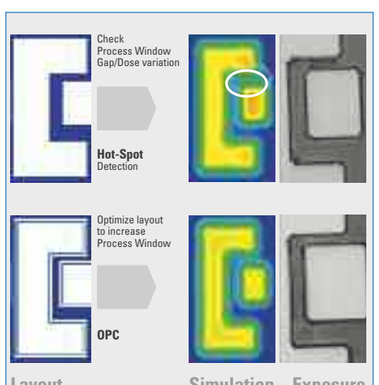
- Models any proximity lithography tool (mask-aligner, contact-printer, proximity-printer), e.g. SÜSS, EVG and large area FPD exposure tools
- Models projection lithography tools such as steppers for IC manufacturing, projection scanners for flat panel display or packaging application
- Laser exposure tools for mask making and direct write, e.g. Heidelberg Instruments and other laser exposure tools
- Models electron-beam lithography tools (VSB, RSB) for mask making or direct write
- Import and Export of all major layout formats
- Open format for data-exchange with other software (CSV, GDS, others on request)

Flexible Licensing and Platform Support

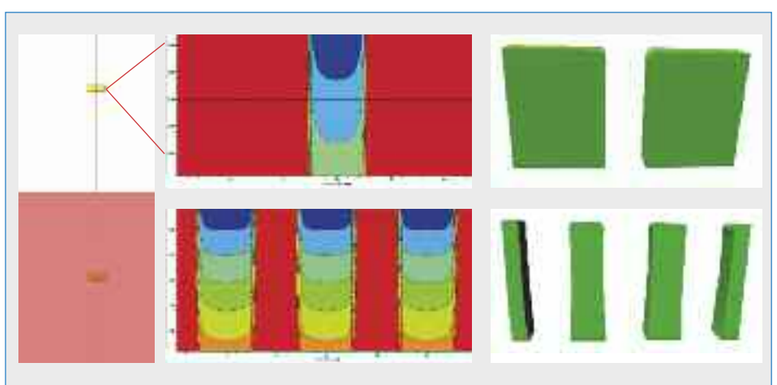
- Flexible License for PC, Workstations and Network sharing
- Runs on off-the-shelf PC's (>4GB RAM recommended)
- Windows 64
- Linux 64: RedHat > v5.0, inquire for other distribution
- Parallel processing: Multithreading, cluster on request

Maintenance and Support

- Hot-line technical support (e-mail, Skype, phone)
- Frequent updates with enhancements, new functions, performance tuning and bug fixes
- Regional trainings, technical workshops, user meetings
- 12 month maintenance service included with license purchase



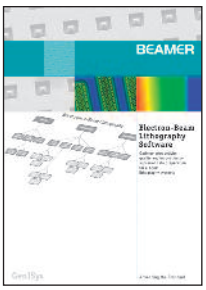
OPC using sub-resolution features for improving the overall process window in high resolution mask aligner lithography



3D e-beam simulation showing density dependent lateral resist development

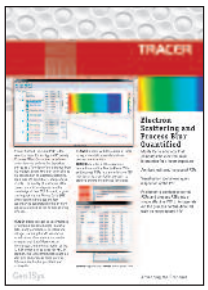
LAB

All in One Lithography Simulation



BEAMER

Electron-Beam Lithography Software



TRACER

Electron Scattering and Process Blur Quantified

Based in Munich, Germany, with offices in Tokyo, Japan and California, USA, **GenISys** develops, markets and supports flexible, high-performance software solutions for the optimization of micro and nano fabrication processes. Addressing the market for lithography and inspection, **GenISys** combines deep technical expertise in layout data processing, process modeling, correction and optimization with high caliber software engineering and a focus on ease of use.

GenISys products give researchers, manufacturers and system suppliers unparalleled efficiency, ease of use and optimal value in research, development and production of future nano-patterning technologies.

As a company focused on customer service, **GenISys** delivers fast, highly dedicated support for application and development of needed functionality to meet demanding customer needs.

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