Welcome to this 2017 third quarter issue of the GenISys Newsletter. New features in the BEAMER, LAB and ProSEM software packages are presented in this newsletter. In addition we continue with our Process Effect Series with the Isofocal Dose-based PEC presented this year at the EIBPN and MNE conferences.

We welcome three new employees to GenISys: Atsushi Nakajima, Doc Daugherty and Peter Horatschek who are introduced below.

BEAMMeetings are the most important occasion where Users and GenISys meet to discuss common interests and future planning. Some of next years meeting dates are included on page 6. We especially welcome you to the BEAMeeting which will be held near Munich, the home of GenISys, next March.

Recent publications by GenISys employees are also listed on the last page.

Congratulations to GenISys employees Kerim Arat and Thomas Klimpel for the Best Poster Award for their virtualSEM presentation titled “Model sensitivity analysis of Monte Carlo based SEM simulations” at the NanoTR conference held in Antalya, Turkey in October 2017.

Atsushi Nakajima’s first experience of EBL was in 1990 as a sales agent of Elionix for overseas. Initially he was involved in developing the market in Asian countries such as Korea, Taiwan and Singapore, and also the US at later stage. He worked for Elionix until 2012, and then joined Raith Asia in Hong Kong. Before joining GenISys KK, he worked at a Japan subsidiary of the US based software company offering a line of application-specific imaging software solutions for the scientific and industrial imaging community.

Doc Daugherty joined GenISys in September 2017, and is our Field Applications Engineer for North America. He received his B.S. in Materials Science from the University of Washington, with research focused in novel perovskites and nanomaterials for flexible electronics. He also was employed at the Washington Nanofabrication Facility where he gained experience in wafer processing, optical and electron beam lithography.

His interests include: travel, music, photography and his dog.

Before GenISys Peter Horatschek worked for Varian Medical Systems on software design and development for a proton therapy system used in cancer treatment, and as a software developer and later project manager at Göpel Electronics. He holds a diploma in computer science from Friedrich-Schiller University in Jena. Peter works as a software engineer in our Jena branch.

Hobbies include chess, geocaching, and walking, especially with his dog.
GenISys Newsletter

Keep up-to-date on GenISys Software Products

New features include
- New Etch Module
- Material library
- Rule-based OPC
- Model-based OPC for Projection
- Post Exposure Bake in Resist
- New Projection multipole source

Modelling of wet and dry etching processes:
- Vertical and lateral etch rates
- Etch front over time

Material Library
- Improved user interface
- Easy viewing and editing
- Improved documentation capabilities

Rule-based OPC for all exposure types
- Rules defined using experimental data: layout biasing, iso-dense biasing, size, area, distance, density dependent etc.
- Resolution Enhancement features: serifs, hammerheads, scatter bars, etc.

OPC for Projection
- Exposure modelled at layout edges, compared to target and modified to compensate for mismatch.
- Any angle, user defined priorities

LAB 4.8.0

New features include
- Improved FRACTURE module
- Python 3 implementation
- Replace Module update
- Hierarchical Processing improved
- Save Documents

Enhanced Write Control in the Fracture Module:
Assign different exposure options, multipass mode, overlap method and field sorting to selected regions. Each option has its own settings window, shown below are the multipass mode settings. Having setup the write control the user can in addition manually resort the field exposure order giving the ultimate pattern exposure control.

Download documents:
This feature downloads the Manual, Specific Formatter Notes, Release Notes and License Agreements in pdf format to a user-selected folder.

Single line edge smoothing:
Single line edge smoothing is an exposure strategy in which all feature edges are traced using a single-line shape while the bulk of the shape is then exposed with trapezoidal beam filling, useful to improve line edge roughness. This feature has been implemented for a first machine type, experimentally verified and published at EIPBN 2017; see page 6 for publication information (Improvement of Silicon Waveguide … publication). Implementation on other machines will follow.

BEAMER 5.5

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Keep up-to-date on GenISys Software Products

- Automatically find similar features in an image
- Fit array Parameters to found features
- Batch measurement of images
- Statistical summary tables
- New feature Type: Ellipses

User Interface and display improvements

Automatically find similar features can be used to find regular or irregular features on an image having initially found the first feature in a series. Applies to 1D gratings or 2D arrays.

Batch mode

A single feature or array can now serve as a template to be detected in all other images of the project. This is triggered with a new "Run Batch Measurements" button. Load a folder of images, do the first measurement which acts as a template for the following measurements. In this manner a series of Dose vs. CD measurements can be automatically measured and the results in a tabulated form obtained.

Ellipses can now be measured, results pictured opposite.

Auto variables and Data Summary Tables

User variables, text or numeric data such as Wafer-ID, Exposure Dose etc. can be defined. Values can be entered with each measurement or directly in the table. Each measurement is identified (labeled, tagged) with its variable values. Variables can be used in the new Summary Table capability to group data computations. From the table of a series of measurements a summary including all the relevant data can be obtained. Shown opposite are reduced views of such tables.

Display options

Having measured an array of circles, pictured right and using the Find Similar Features option, the display can be switched between Array Guides and Interactive measurements.

Future Development Plans, Multi-Edge (complex features)

Certain applications such as asymmetrical III/V transistors require multi-edge measurements as shown opposite. An empirical model with flexible edge types will be developed to handle these issues.

Variables

User-defined variables will be introduced allowing formulas for calculations to be defined. Examples include feature spacing (overlay), sidewall angles, aspect ratios, duty cycles etc.

Visit the GenISys ProSEM website for additional features tutorials, videos and more updated information.
Keep up-to-date on GenISys Software Products

What is the “best” exposure/process point (Base Dose) for a given pattern? Using TRACER to find the “isofocal point” helps to answer this question. For a given stack, CD measured is a function of dose and pattern density as shown above. The isofocal dose in electron beam lithography is defined as the dose that results in the same feature size independent of the effective blur (blur\(_{eff}\)), which is the result of a combination of resist processing, spot size, beam focus, forward scattering, etc. that contribute to the final resist image. In other words, as blur\(_{eff}\) changes the same feature size is still obtained while using the same dose. Process robustness is achievable by exposing with the isofocal dose.

The isofocal point is the intersection of different blur\(_{eff}\) for a target CD at the resist threshold as shown below left. The CD response is directly proportional to the applied dose. The edge slope of the blur directly impacts the slope of the exposure latitude and ultimately the process window for given CD tolerance which is illustrated above, right. Therefore, a good blur\(_{eff}\) that has a steep edge slope at the resist threshold will yield an exposure latitude with a shallow slope, while a poor blur\(_{eff}\) that has a shallow edge slope at the resist threshold will yield an exposure latitude with a steep slope. As one can infer, a good blur\(_{eff}\) simply implies a focused beam, where a poor blur\(_{eff}\) implies a defocused beam. Consequently, a similar behavior will be seen in their exposure latitudes.

If proximity effect correction (PEC) yields the appropriate pattern density dependent isofocal doses, the same feature sizes will be consistently attainable across all pattern densities regardless of the beam focus accuracy. The images below show the results obtained for 60 nm and 48 nm structures both the uncorrected and corrected patterns. As can be seen, the correct patterns approach the design CD values.
Impressions from the BEAMeeting held at the MNE in Portugal, September, 2017 and GenISys booth at the MNE exhibition.
Upcoming Events in 2018

- SPIE Advanced Litho, San Jose, USA, Feb. 2018
- BEAMeeting Munich, Germany, March 14 - 16, 2018
- EIBPN Puerto Rico, 2018
- BEAMeeting at the MNE, Copenhagen, Denmark, September 2018
- MNC, Sapporo, Japan, Nov. 13 - 16, 2018

Two recent publications by GenISys employees:

Isofocal dose based proximity effect correction tolerance to the process blur
Gerald G. Lopez, Mohsen Azadi and Meredith G. Mettler.

Improvement of silicon waveguide transmission by advanced e-beam lithography data fracturing strategies