GenISys Newsletter

Editorial

Keeping Customer Driven while growing…

The main differentiator and key to success of GenISys has been and is the close connection to, and cooperation with its users. All development have been user-driven from day 0 until today. We have collected user input by working with pilot customers, hosting BEAMeetings and other technical workshops, attending the major conferences and by the day -to-day work of our field application engineers.

With the growing number of users, we have now reached more than 220 BEAMER sites almost equally distributed in Europe, US and Asia; this is getting quite challenging. One action is to increase the number of our field application engineers in the regions. Currently we have posted open positions for field application engineers in Europe and China. However even with more application engineers with the number of installations reaching 100 per region, it is getting impossible keeping contact by regular visit or local workshops.

The other action is to better utilize internet communications by improving access to application notes and documentation, arranging on-line trainings and technical workshops. We are currently working on new application notes and will take action for better distribution by improving the download area of our website. In parallel we will test regular online trainings and technical workshops, which can be attended via internet by users globally.

Our aim is to open new channels for technical communication with the users to keep the development of our of products according to your needs and wishes. We are looking forward to your contributions and suggestions.

In this issue some of the highlights in our BEAMER, LAB and Pro**SEM** updates are featured. LAB and Pro**SEM** updates have been released; BEAMER 5.9.0 will follow shortly.

The negative HSQ resist with respect to process effects and an update in TRACER is discussed on page 4. HSQ resist is a popular high resolution resist, however, with some ‘strange’ proximity effects which can be corrected for.

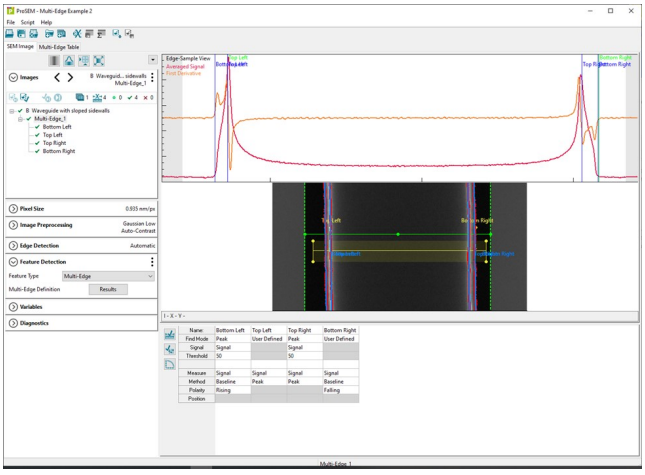
We are proud to include the Cavendish Laboratory, the Department of Physics at the University of Cambridge, and which is part of the School of Physical Sciences in our GenISys User Profile. The Cavendish is a long term GenISys software user with extensive E-Beam technology experience.

Finally we welcome three new members to the GenISys team profiled on page 3.

Just released, Pro**SEM** v2.6 will provide some major new capabilities for users with more advanced needs. A significant new capability will be an entirely new feature type specifically to measure images with more complex edges, where a single edge fit might not be sufficient, or where several edges are in very close proximity. This edge finding will offer the user more options for how to identify and measure these edges, including using the derivative signal or manually identifying the desired measurement point on the image or signal. The edge following will also be improved by utilizing a more advanced and intelligent edge tracing algorithm.

Another powerful feature will be full application scripting, which will enable entire measurement tasks to be automated, from image loading, through measurement and export of the measured data. In addition to the SEM image, many tools also store information about the image and instrument settings, either embedded in the image, such as tags in TIFF image files, or as an external adjunct file, typically a .txt or .csv file. When metadata is available, Pro**SEM** reads the pixel size for each image; this is displayed in the Pixel Size panel and used for all measurements.

The ProSEM website includes a number of step-by-step examples, as well as tutorial videos. “ProSEM In Action” includes many application examples of interest to Pro**SEM** users.



A Multi-Edge measurement is defined as a series of edges within a single ROI. The edges are ordered from left-to-right, or bottom-to-top. When a Multi-Edge feature type is selected in the Feature Detection panel, a table is displayed in the panel beneath the image panel.

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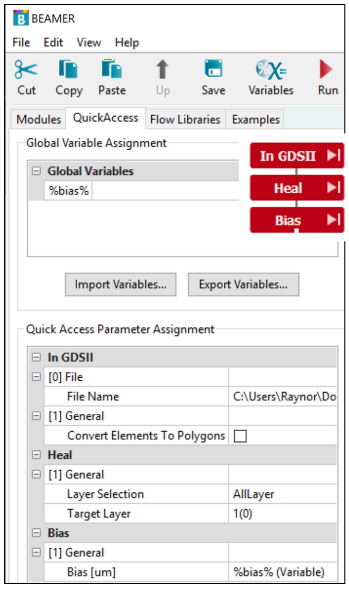
GenISys GmbH

Keep up-to-date on GenISys Software Products

2/ 2019

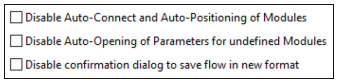
BEAMER 5.8.0

Some of the new features in BEAMER 5.8.0 are illustrated below.



QuickAccess is now integrated into the Modules & libraries Panel. Pictured left are the QuickAccess parameters activated in the modules shown in the inserted flow. Parameters can be a file name, a selection box, a numerical value or a layer number. Global variables (here the Bias value are included in this panel).

Disable module (Right mouse-click on module) and data passes though module unaffected.



New options are available in the File/Properties settings.

BEAMER 5.9.0

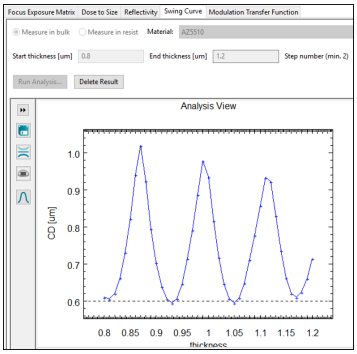
Enhancements in the upcoming BEAMER version include:

- Python: version independent, improved model structure
- License management: Tracking of license usage
- Allow moving and resizing of regions
- Extract highlights cells in selection dialog
- 3D Laser PEC improvements
- HIMT write time estimation
- An improved BEAMER Properties section
- Running Flows can be *Suspended* and later *Resumed*

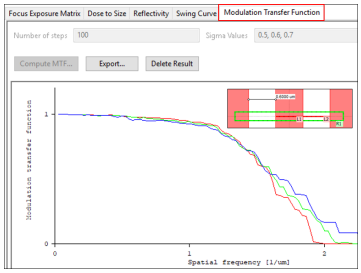
BEAMER Update

LAB 5.2.0

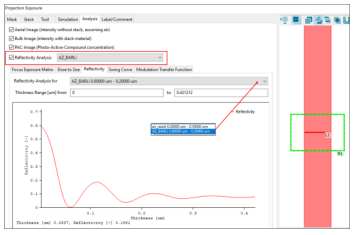
Some of the new features in LAB 5.2.0 are illustrated below. In the optical simulation modules it is now possible to determine the swing curve, modulation transfer function and reflectivity for a given resist.



A *Swing Curve* is defined as a sinusoidal variation of a parameter, such as linewidth or dose-to-clear, as a function of resist thickness caused by thin film interference effects. The amplitude of the swing curve is controlled by the reflectivity of the substrate.



The *Modulation Transfer Function* (MTF) is a description of the imaging properties of an optical system. It is useful in comparing the relative performance of exposure tools when operating near their resolution (diffraction) limit.



A reflectivity vs. thickness curve is automatically displayed in the Reflectivity Analysis option of the Analysis tab or Results tab. Moving the mouse position over the graph displays the reflectivity value for a given thickness. The Reflectivity Analysis can be applied to both resists and ARCs for optical simulations, and also over loops using for example, n and k values. In the next version, an improved LAB Properties section will be implemented, as in BEAMER.

LAB Update

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GenISys is strengthening its Global Team

Haiyan Cozzio-Fu joined GenISys GmbH in Taufkirchen in October 2019 as a Marketing and Sales Assistant. Haiyan comes from China and studied Business Administration in Augsburg University. She accomplished her thesis in Yahoo! Germany and in addition, she worked in Export Trading Sales for 5 years in China and a few more years in the China Sales and Marketing Department in Siemens AG as a working student. In the last company she worked for Droege & Comp. as a business analyst. Her strengths lie in her customer oriented attitude and strong analytical ability. In her leisure time she enjoys cooking and hiking.

Sven Meyer joined the GenISys development team in Jena in April 2019. He has a background in theoretical astrophysics and cosmology. After his PhD, he spend another 4 years as postdoctoral researcher at the Center of Astronomy at University of Heidelberg. His research fields included theoretical cosmology and general relativity, in particular, inhomogeneous cosmological models, perturbation theory and their numerical treatment. His professional knowledge includes numerics, mathematical algorithms and scientific software development. In his leisure time, he enjoys cycling and hiking with his family.

Klemens Reuther joined GenISys in November 2019 and is based in the software group in Jena, Germany. His background is in metal physics, both theory and simulation of microstructure formation (i.e., solidification) and also nonequilibrium solidification. He worked on the development of two and three dimensional models for the description of the moving solidification interface, and has a strong background in interpolation methods. Additional experience includes microstructure analysis, especially using SEM. Personal interests include music and being a member of a choir.

Welcome to GenISys and enjoy the stimulating and exciting development being done in our company.

Open positions

Applications Engineers for Europe and China

We are looking for a highly motivated applications engineers based in Munich for Europe, and in Shenzhen or Shanghai for China to support customers on adaptation of GenISys' products. Duties include presale (product demonstration, technical support of evaluations) and post-sale support (installation, training, de-bugging and resolving customer issues) as well as contributions to documentation such as application-notes and/ or white-papers that promote the ease-of-use of our products. The Applications Engineer also champions customer needs for product improvement and provides input to the product development team for long-term planning and prioritizing functional changes and additions to products.

Job Qualifications and Requirements

- We are seeking a highly motivated, results-oriented and accountable person that flourishes in an international environment.
- BS or equivalent in Electrical Engineering or related discipline is required, MS preferred
- At least 3+ years of experience as a Lithography Process Engineer or related fields
- Broad understanding of E-Beam, Laser and Projection Lithography systems and nano-fabrication processes
- Strong IT background, experience with Unix and Linux OS, high-level scripting/programming skills (Python) in the CAD environment
- Ability to quickly develop a deep understanding of technology and able to explain and optimize experimental results
- Ability to uncover new business opportunities and articulate the potential to Sales Management
- Motivated team player who enjoys working with customers with strong communication skills including English communication

Software Engineers for Europe

We are looking for a highly motivated software development engineer to work on GUI components, visualization capabilities and core algorithms of our products in the field of layout data processing, lithography simulation and process effect correction at our office in Munich or Jena (Germany). You will be contributing to final production level quality of new components and algorithms and support existing components.

Job Qualifications and Requirements

MS/Diploma in Computer Science, Electrical Engineering or related discipline with experience in coding/enhancing software products. Strong background in algorithms and data structures, specifically in the area of computational geometry is preferable. Experience in the field of semiconductors, IC layout processing, computational lithography, or distributed processing (including experience in MPI) is a nice to have. Individuals with strong ability to learn and explore new technologies and who are able to demonstrate good analysis and problem solving skills are preferred. You will need excellent programming skills in C++ on Windows and/or LINUX platforms as well as a strong background in the stl and boost libraries. Self -motivation, self-discipline and the ability to set personal goals and work consistently towards them in a dynamic environment will go far towards contributing to your success.

Please send your application to jobs@genisys-gmbh.com

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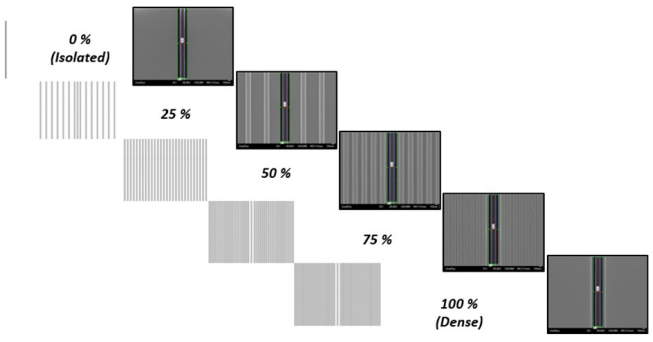
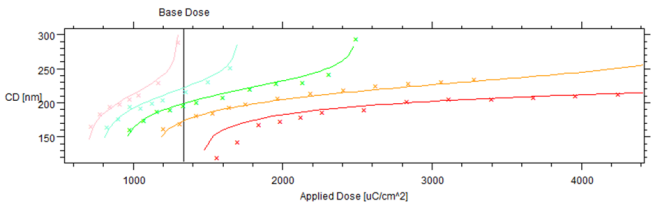
HSQ Process Effects

In an earlier issue, we discussed the Full Process Calibration capability in TRACER, in which empirical measurements are used to extend our point-spread-based Proximity Effect Correction. In this, key process parameters of effective process blur, optimum base dose, and density-dependent process biases are determined by fitting post-process linewidth measurements. These parameters are then applied along with PEC to improve lithography results. The new TRACER version 2.8 extends this by adding a mid-range fitting and correction term. While useful for compound semiconductor substrates, this new mid-range correction has also demonstrated utility in compensating for unique effects in HSQ resist processing.

HSQ is a negative, inorganic resist known for high resolution, low edge roughness, and challenging process behavior. Among the unique difficulties are a "strange" proximity-like effect where the effective dose appears different depending on prior nearby exposure, and an exposure-order non-reciprocity, leading to writing order effects in which the resulting feature size depends on the write sequence of nearby features. Research in the early 2000s (Liddle and Olynick, 2003 and 2006) showed these effects are likely due to hydrogen being released during e-beam exposure of HSQ, which then diffuses to nearly regions of unexposed resist and reduces the exposure dose in those nearly regions. While this is a different mechanism than energy from scattered electrons, the effect of the diffused hydrogen can be characterized and compensated by our Full Process Calibration.

Seen here are fitted measurements of HSQ, following our Full Process Calibration procedure, with the measured CD plotted against written dose for 5 densities from isolated to dense.

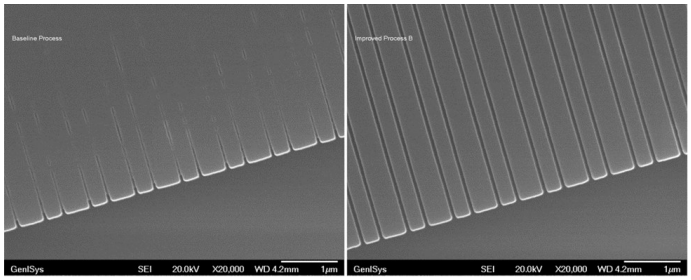




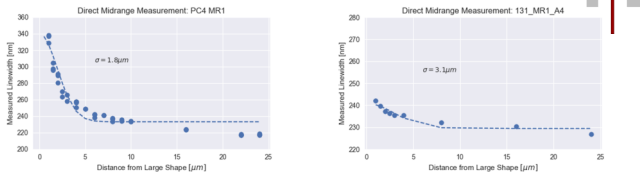
The fitted process parameters were then used to a silicon photonics application based on HSQ resist, with the baseline and calibrated process correction parameters shown in this table. It must be noted that a Multipass writing strategy was also employed, which was shown to mostly eliminate the writing-order dependence effects.

	Before Calibration Chosen by 'Traditional Method'	Calibration Parameters Determined by TRACER fit to Measured CD Data
Base Dose	1750 µC/cm²	1340 µC/cm²
Process Blur	50 nm	36 nm
Process Bias	None	-3 nm
Density-dependent Bias	None	0% = 0 nm, 25% = 1 nm, 50% = 2 nm, 75% = 2 nm, 100% = 3 nm
PEC Parameters	Simple Two-Gaussian α=10 nm, β=30000 nm, η= 0.6	Additional Mid-range Gaussian α=10 nm, β=30000 nm, η= 0.6 γ= 3722* nm, ν=0.38*

The calibrated process significantly improved the process capability at higher pattern densities, which have long been a challenging weakness for HSQ processing. The before/after SEM images shown here are a very large grating with an 82% pattern fill density, which was not possible using the baseline process, but is cleanly defined using the process point fitting using TRACER's Full Process Calibration.



Direct measurement shows values of 1.8 and 1.3 µm length scale for the midrange term.



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2/ 2019

GenISys Customer Profile

The Cavendish Laboratory is the Department of Physics at the University of Cambridge, and is part of the School of Physical Sciences. The laboratory was opened in 1874 on the New Museums Site as a laboratory for experimental physics and is named after the British chemist and physicist Henry Cavendish. The laboratory has had a huge influence on research in the disciplines of physics, chemistry and biology; it has been host to 29 Nobel Laureates including J J Thomson, discoverer of the electron.

The Leica VB6-HR

The Cambridge E-Beam Lithography facilities include two 100kV e-beam systems: a Leica VB6-UHR, in service since 2003; and a Raith EBPG 5200 acquired in 2018. Both are now part of the Cambridge Royce Nanofabrication Suite.

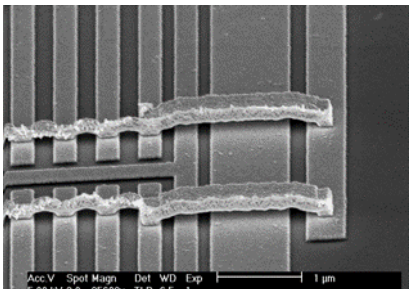
The new EBPG 5200 has capacity for semi-standard wafers up to 200mm diameter. Its advanced Universal Pattern Generator, running with a maximum 125MHz exel clock, features advanced primitives providing the highest fidelity shape writing.

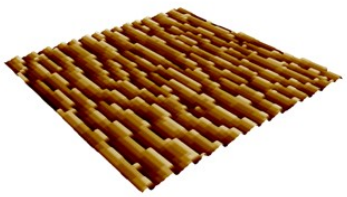
Both machines feature 100kV acceleration voltage, enabling applications with high aspect-ratio resist structures whilst minimising the effects of scattering and proximity dose.

Cambridge University Cavendish Laboratory

The facility transitioned to GenISys software (Beamer, Proximity and Tracer) in 2009 after extensive evaluations were made of its capabilities for handling large data volumes necessary for the commercial work we undertake. The facility has particular experience in the field of greyscale lithography. We are able to produce surface relief patterns in resists as thick as 1um for diffractive optical applications. T-gate structures, and air-bridged contacts are also possible, with Beamer's 3D proximity-effect correction enabling critical dimension control independent of patterning density.

The new Cavendish III laboratory.





Examples of greyscale lithography employing 3D-PEC

UNIVERSITY OF CAMBRIDGE

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Upcoming Events in 2020

BEAMeetings and Conferences at which GenISys will participate

- BEAMeeting at SPIE Advanced Litho Conference, San Jose, USA, 23-27 February
- BEAMeeting at GenISys, Munich, 23-24 March
- Photomask Japan in Yokohama, 19-21 April
- EIPBN 2020 in New Orleans, USA, 26-29 May
- EMLC European Mask and Lithography Conference in Leuven, Belgium, 22-24 June,
- MNE 2020 in Leuven, Belgium, 14-18 September
- SPIE BACUS Photomask Technology in Monterey, USA , 20-24 September,
- MNC 2020, in Osaka, Japan November

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