

## Physical modeling using NovaMARS<sup>®</sup>

### Introduction

Since its introduction more than a decade ago, scatterometry has made significant progress towards maturity. Today scatterometry is able to measure embedded details and critical profile parameters of complex 3D device structures. Reliable measurements of such details, that are practically invisible by any other technique, makes scatterometry an indispensable instrument for both device development and process control.

Advanced process development is characterized by frequent changes to structures and metrology requirements. Scatterometry solutions have to keep up by providing fast and accurate profile information. By speeding up recipe creation and allowing timely device profile measurements, NovaMARS enables our customers to utilize the power of scatterometry to shorten the process development cycle.

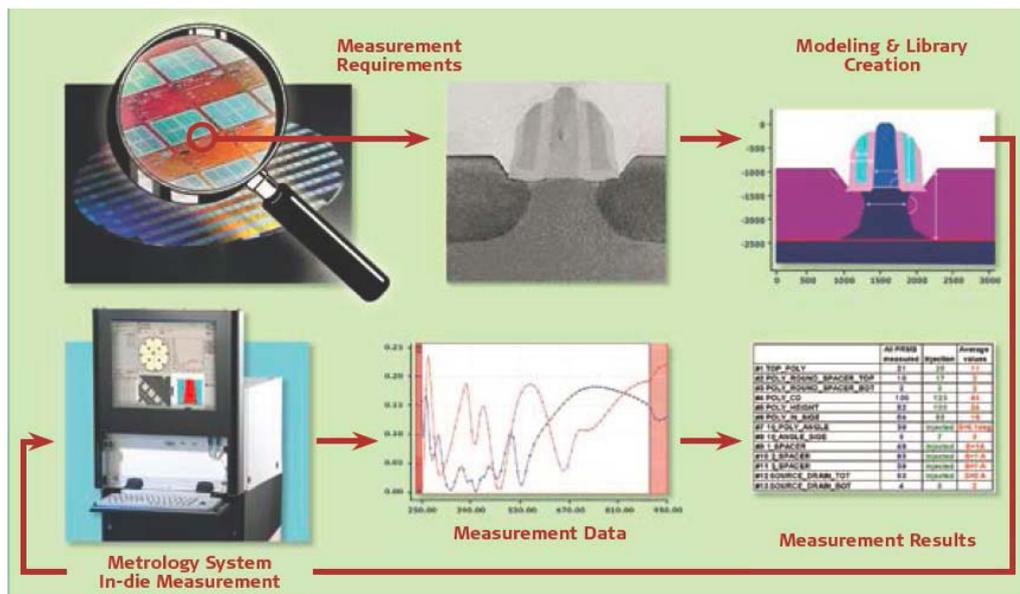
### Application development cycle

The NovaMARS (Metrology Analysis & Recipe Setup) scatterometry engine has the ability to combine data from multiple optical channels directly on the tool during measurement. This multi-channel capability complements the existing holistic metrology elements such as injection, multi-stack and global fit to provide the most comprehensive algorithmic solution for scatterometry applications development to date.

NovaMARS provides an automatic and easy-to-use solution for advanced structure modeling and application development for the most complex 2D/3D device structures in the advanced technology nodes.

The strength and adaptability of Process Oriented Modeling Flexibility (POMF) allows process engineers to develop their own scatterometry solutions, keeping the details of their process within the FAB.

NovaMARS meets the industry demanding needs for 2D and 3D test scatterometry target and in-die measurements, optimizing metrology tool performance and significantly shortening the application development cycle.



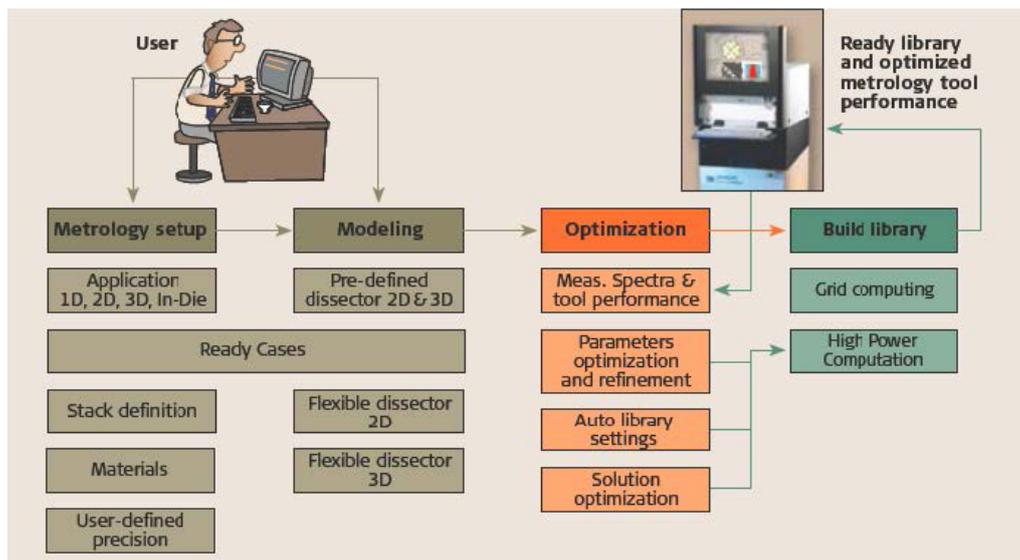
An overview of the application development cycle

Measurement requirements in today's ever-increasing, complex IC manufacturing environments are quickly moving to 3D in-die measurements. As a result of this industry situation, metrology specialists are forced to spend an increasing amount of time developing metrology recipes. NovaMARS (Metrology Analysis & Recipe Setup) provides an automatic and easy to use solution for advanced structure modeling and application development for the 45nm technology node and beyond.

The high level of automation enables easy and fast application development and eliminates discrepancies between different developers, independent of user proficiency. The strength and flexibility of Process Oriented Modeling Flexibility (POMF) allows process engineers to develop their own scatterometry solutions, keeping the details of their process within the FAB.

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The following figure provides an overview of the modeling and application development process in MARS.



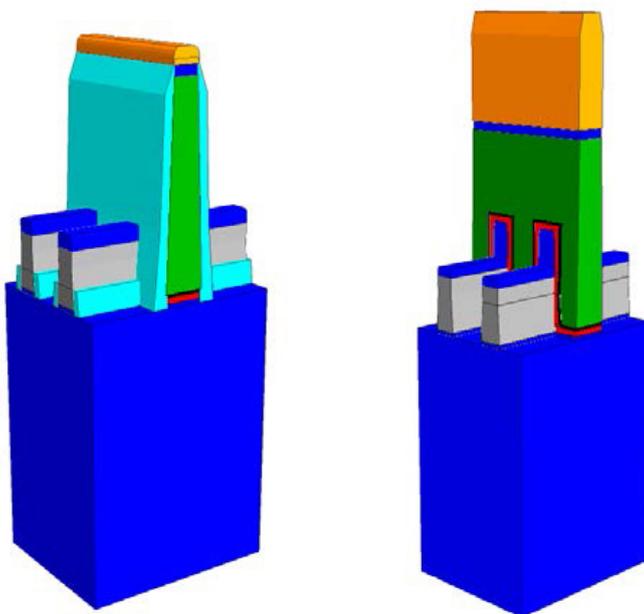
An overview of the modeling and application development process

## Modeling and Simulation

### Build the model

The Stack Maker is an interactive stack editor that enables you to create and edit the NovaMARS stack models in a visual, user-friendly way.

Advanced process-aware Geometry setup in MARS StackMaker - definition of stack geometry shapes by mimicking the process steps of semiconductor production, including Barrier layer, Blanket deposition, Linear coating and Spacer addition steps. StackMaker combines the flexibility of complex shapes modeling with the ease-of-use and advanced visualization.

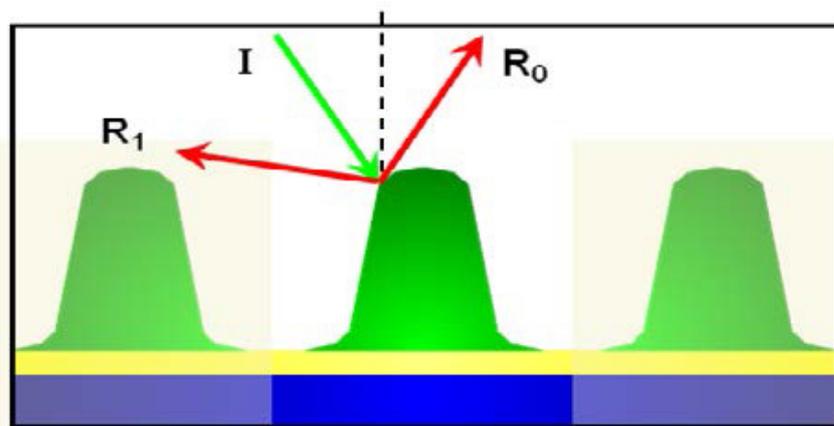
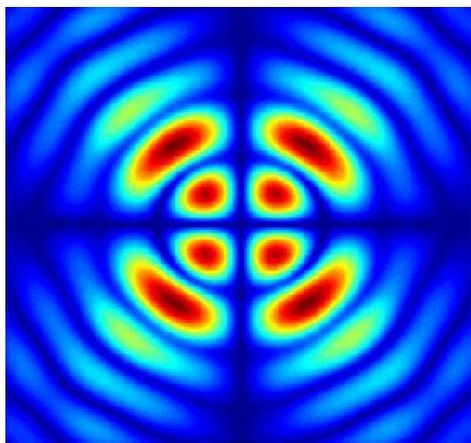


The various features and functionality provided by the StackMaker in addition to the existing UCELLA stack editor, include:

- 3D Visual viewing and editing
- Drag-and-drop
- Copy/paste
- Grouping into a template
- Snapping the parameter shapes and links
- Working with the linear layer; working with the dent of an existing shape; template replication
- Visual editing of the links between Shapes, Parameters and Macros.

## Calculate the Electromagnetic field

In order to model Scatterometry spectra, MARS performs rigorous simulation of Electromagnetic field scattering in 2D and 3D layered periodic structures. The modeling can be performed on non-repetitive or non-periodic structure as well. See also TSV modeling at our publications page: [http://novameasuring.com/technical\\_publication.html](http://novameasuring.com/technical_publication.html)



MARS supports sophisticated algorithms for the optimization of materials optical properties, based on analytical expressions of Drude-Lorentz model. MARS also supported material modeling of novel mixed materials such as SiGe which can be described as a collection of  $n$ & $k$  tables parameterized by "concentration".

## Real Time Regression and Libraries

The calculation of the reflectance spectra is used in various ways within the NovaMARS scatterometry engine. Real Time Regression (RTR) is used during the application solution development in order to do interpretation and matching between measured spectra to the theoretical calculated spectra.

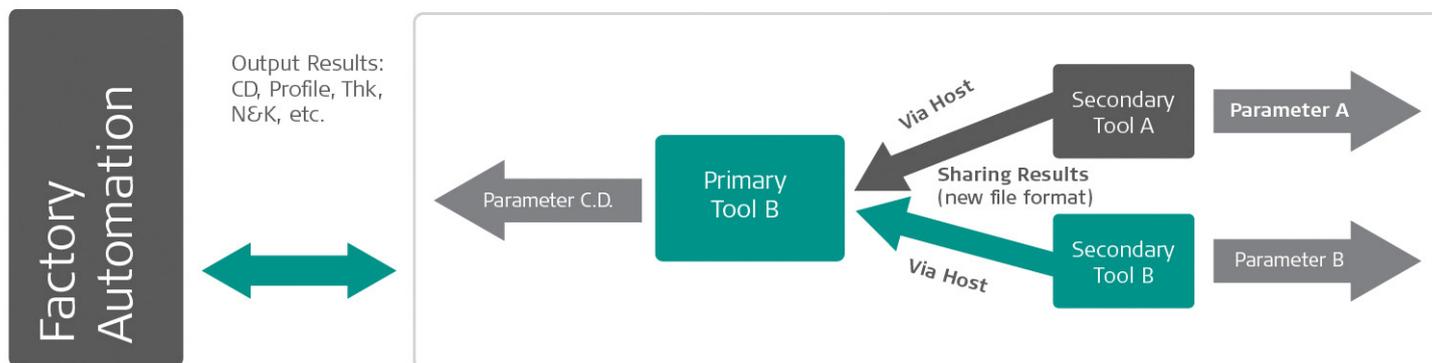
Another option for using RTR is to perform it online, on the metrology tools, for interpretation of the measured spectra in order to achieve fast time to results.

Traditionally, the NovaMARS metrology solution is based on generation of libraries. The library is a set of calculated spectra that is used for the interpretation of the measured spectra.

The NovaMARS is using a smart libraries method called compact library (CLB). The CLB is a set of pre-built interpolants that is built for a distinct parameter workspace. The compact library lets you calculate the spectra with the given interpolation accuracy. The library parameter workspace may include both geometry and material parameters of the stack.

## Hybrid Metrology

### Hybrid Tool



MARS supports a novel Hybrid Metrology strategy that combines multiple types of metrology tools in union to produce a single combined result. Hybrid Metrology is an enabler to overcome traditional metrology challenges with increased recipe robustness and reduced inter-parameter correlation.