Optimization of Model-Based Library Algorithm for Metrology with CD-SEM

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Critical dimension scanning electron microscope (CD SEM) is one of the most versatile techniques used for in-line semiconductor devices metrology to monitor and improve yield and process[1]. CD SEM measurement depends on secondary electron (SE) and backscattered electron (BSE) signal intensities to derive edge positions. Shrinking feature sizes and complex three-dimensional device structures place increasing challenges on CD SEM. In order to develop new nanostructure manufacturing processes, such as the fabrication of FinFETs, metrology requires strict tolerances, but also introduces additional critical process parameters such as sidewall angle and height[2,3]. The dimension metrology based on SE and BSE image should have greater potential for 3D metrology. However, the empirical algorithms are difficult to meet the requirement. To satisfy measurement tolerances and the tight CD control requirements, the metrology algorithm based on physics model should be the best way. Monte Carlo (MC) simulation has played an important role in the progress of CD metrology algorithm. In principle the model-based library (MBL) method should be an ideal choice for CD SEM metrology at advanced nodes[4]. However，metrology based on MBL needs big simulation data from various modelling, which is a challenge for high-accuracy in-line measurement in practice.

In this study, Nebula Monte Carlo electron simulator has been used to create a simulation database. Based on the simulation database, a MBL method with Meta-heuristic optimization algorithm, which does not require gradient information and can bypass local optima is carried out for faster and low-bias measurement. Figure 1 shows the iterating process through the multidimensional parameter space of a model-based library. Figures 2(a) and 2(b) demonstrate the significant effect to reduce average and maximum errors in processing a batch of examples with the optimized model-based library algorithm. It is expected the improved model-based library algorithm has better performance in three-dimensional metrology. More results and details of our study will be presented at the conference.

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[1] N. G. Orji *et al.*, *Nat Electron.* **1**, 532-547 (2018).
[2] J.S. Villarrubia *et al.*, *ULTRAMICROSCOPY.* **154**, 15-28 (2015).
[3] B. Bunday, *Proc. SPIE.* **9778**, 97780E (2016).
[4] B. Bunday, A. Cepler, A. Cordes, A. Arceo, *Proc. SPIE.* **9050**, 90500T-1-20 (2014).

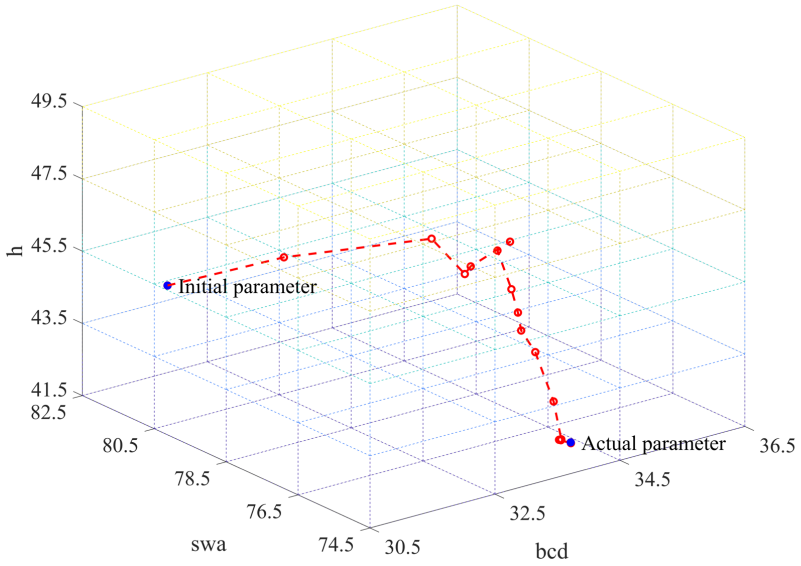

Fig. 1. The process by which an optimization algorithm finds the best matching result in the parameter space of simulated data.

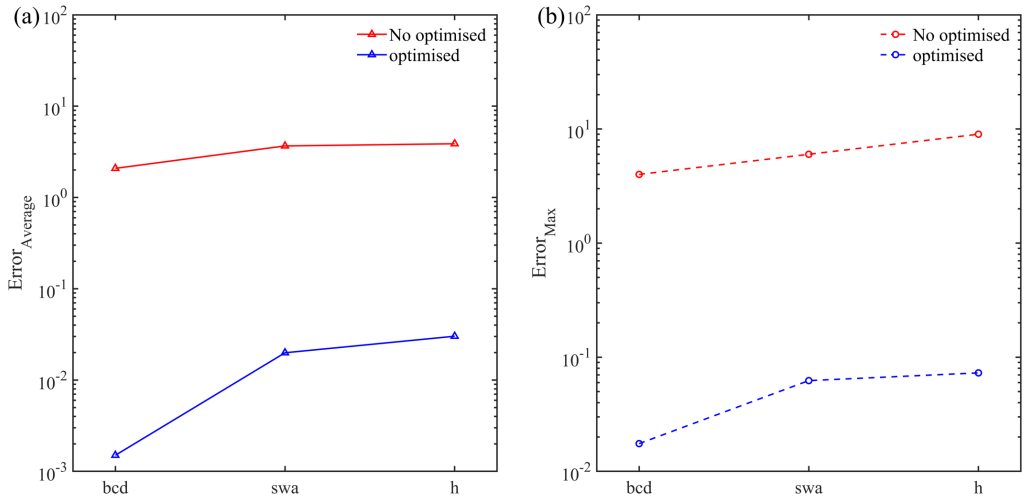

Fig. 2. (a) Comparison of average errors with or without optimization of model-based library algorithm, (b) Comparison of maximum errors with or without optimization of model-based library algorithm.