Reducing the pattern redundancy in OPC modeling by analyzing the pattern linearity

Jianliang Li[a], Lin Zhang[b], Qiliang Yan[a] and Lawrence S. Melvin III[a]
a. Synopsys Inc., 2025 NW Cornelius Pass Rd., Hillsboro OR 97124, USA
b. Synopsys Inc., 700 E. Middlefiled Rd. Mountain View, CA 94043, USA
jlli@synopsys.com

In modern photolithography, optical proximity correction (OPC) has been widely adopted to improve the image fidelity of the mask on silicon wafer and, hence, improve the yield and performance of integrated circuits. Before OPC is conducted on the full chip, it is crucial to build a high quality model that simulates the photolithography process accurately. Prior to the modeling process, measurement data are usually acquired from scanning electron microscope (SEM) images and gauges are placed on the layouts to generate the empirical critical dimensions (CDs). The process model is, then, constructed from a mathematical simulation of the manufacturing process in question with model coefficients found using a cost function that consists of all the empirical CD data.

A high quality OPC model apparently relies on the quality of the empirical CD data in terms of both metrology noisiness and layout representativeness. While it is very important to acquire the empirical data with minimum metrology noise, the focus of this paper is on how to identify the most important and representative patterns before building OPC models. Although more measurements on a large number of patterns will keep overall noise at lower levels and provide better input to OPC modeling, it is crucial to choose the representative patterns wisely and minimize the redundancy of gauges, due to the limited metrology budget and the requirement of shortening turn-around-time.

In this paper, we propose a method that checks the linear response of the 1D layouts on the optical signal and selects the representative patterns among all possible measurements. One example is shown in figure 1, in which 1D structures with a fixed line-width of 140nm and pitches from 200nm to 1100nm are studied. In the study, an optical model was built with real photolithography settings provided by foundry, model CDs were determined by the intersecting points between the optical signals and a constant threshold, and the model generated CDs were drawn versus pitches. While there are many details in the curve, there exist roughly five linearity zones when pitches increase from 200nm to 1100nm with 10nm increment, as highlighted in the plot. Based on linearity, model CDs can be interpolated from their neighbors with good accuracy. One can then analyze the linearity zones one by one and select those most critical layouts for modeling. And as this method requires only optical signal, it can be done before measurements and provides valid guideline for data acquisition.

The detailed discussion on the new method will be disclosed in the full paper.

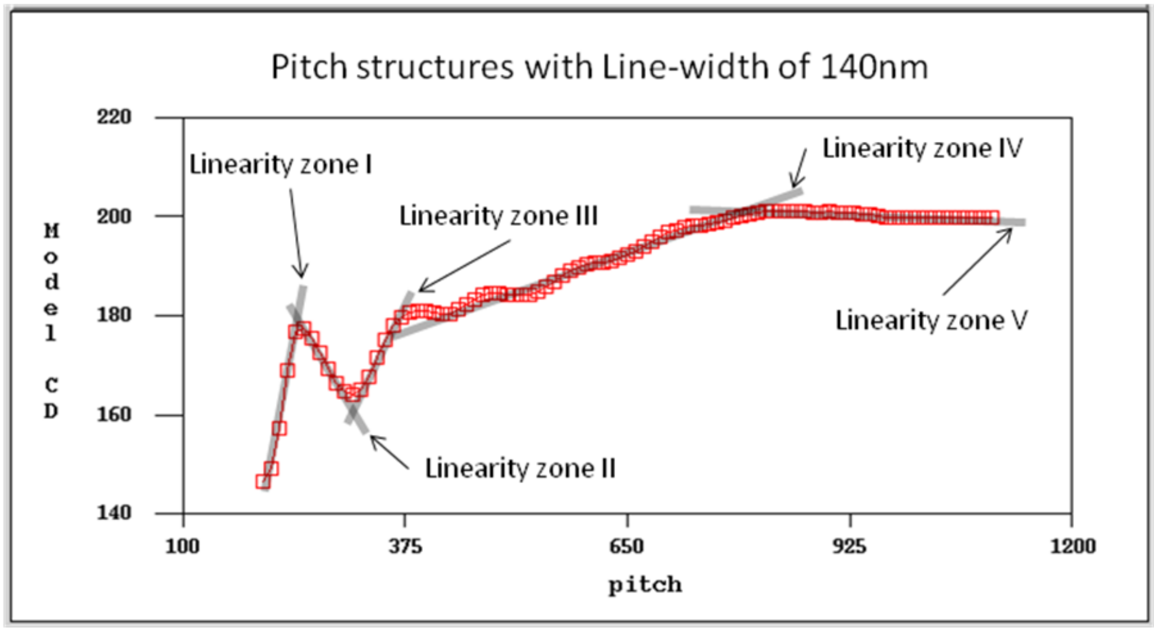

Fig. 1. Linear response of 1D structures on optical signal indicates there are five linearity zones one can use to reduce the pattern redundancy.