Enhanced Optical Critical Dimension Metrology for the 7 nm Node and Beyond Using a Near-field Metalens

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INTRODUCTION

Optical scatterometry, which is a far-field based technique inherently, can be regarded as the most promising candidate technique to meet most of the rigid requirements of process control in the semiconductor industry. The critical dimension (CD) of the features of interest are presently below 20 nm and given current trends will likely reach the atomic scale in the mid-2020s. The downward scaling of the CDs and the increased structural complexity as well as the application of novel materials in semiconductor devices, brings up many grand challenges to the optical CD metrology, such as decreased sensitivity, varying optical properties of materials, tighter process specs, high correlations among fitting parameters, and faster metrology throughput demands.

In this article, we introduce the concept of the near-field metalens into conventional optical scatterometry and through-focus optical microscopy to meet two specific challenges in OCD metrology:
1) ultra-narrow focusing of the beam to do metrology using a 1 μm × 1 μm scatterometry target, and
2) enhancing the signal associated with the 7 nm node patterned wafer.

ULTRA-SMALL TARGET DESIGN

Challenges:

- Reduced scatterometry target size, with some recent projections of targets as small as 10 μm × 10 μm.
- Reducing the size of a focused beam spot for a multi-wavelengths source remains as a challenging engineering issue.

Goals:

- Realizing the metrology of a scatterometry target with a size down to 1 μm × 1 μm and even smaller;
- In support of multi-wavelengths source for one-shot measurement;
- In support of angle-resolved metrology for decoupling the correlations among fitting parameters.

ENHANCED THROUGH-FOCUS IMAGES

We propose a near-field metalens based methodology for improving the through-focus differential signal (TFDS) associated with the critical dimension of the 7 nm node (and even below) pattern on the scatterometry target.

REFERENCES