3D digital holographic semiconductor metrology using Fourier Modal Method

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1. Introduction

Through-focus Scanning Optical Microscope (TSOM) technology, which has been attracting much attention in the field of semiconductor measurement recently, using a conventional optical microscope, collects 2D images at multiple focal positions for creating 3D data space and extracts intensity profile from them. It is a breakthrough technology for the inspection and measurement of a recent complicated 3D structure semiconductor.

However, since this TSOM technology uses physical z-axis movement, jittering necessarily occurs, which seriously affects image reliability. Therefore, in this paper, we propose a 3D digital holography technique, which can calculate the diffractive light wave information of the semiconductor sample in the stationary state without such physical movement.

2. Fourier Modal Method

For this purpose, we use the Fourier modal method (FMM) for modeling of electromagnetic field for a nano-scale semiconductor sample structure as shown in figure 1. The 3D holographic simulation tool with imaging station, such as CCD and objective lens. Figure 2. (a) and (b) show a TSOM image using the typical z-axis movement method and 3D digital holographic method, respectively.

Moreover, we investigate the TSOM image construction under illumination with various degree of coherence. The sensitivity of TSOM converges with the degree of partial coherence before arriving at the complete coherence. This partial coherence condition would be the best coherence condition without the deterioration of the photographic imaging by speckle noise as shown in figure 3.

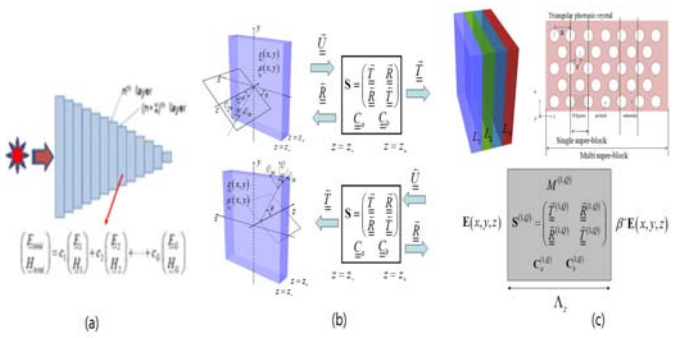

Figure 1. Fourier modal method (FMM); (a) sample modeling, calculation of scattering matrix for (b) single block matrix and (c) multi super block matrix

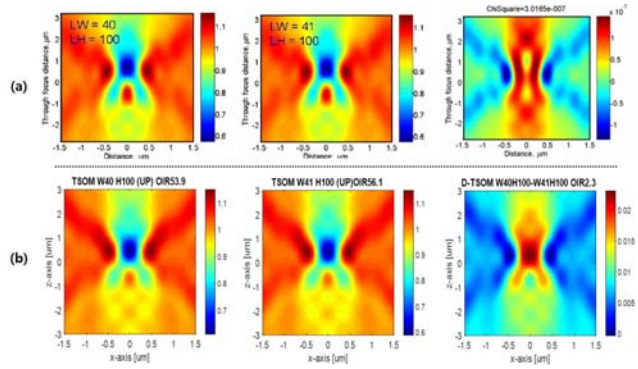

Figure 2. TSOM images using (a) typical z-axis movement and (b) 3D digital holographic method

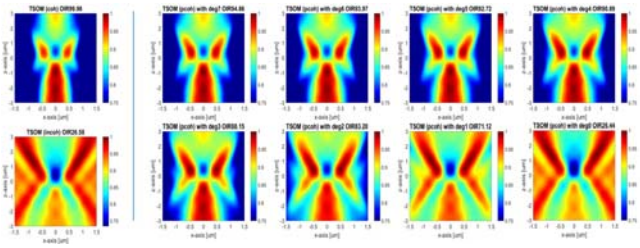

Figure 3. TSOM images with degree of coherence

3. Conclusions

3D digital holographic TSOM method for nano-scale semiconductor metrology has been suggested. We investigated the role of the degree of coherence of the illumination and have found that the coherence illumination is more effective than the conventional incoherent condition. From the above results, which are obtained using FMM, we can confirm the possibility and performance of 3D digital holographic TSOM technology.

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