

Tomographic Mueller-matrix Scatterometry for Nanostructure Metrology: Principle and Opportunities

Xiuguo Chen, Yating Shi, and Shiyuan Liu

Email: xiuguochen@hust.edu.cn, yatingshi@hust.edu.cn, shyliu@hust.edu.cn

Nom Group: <http://nom.mse.hust.edu.cn>

State Key Laboratory of Digital Manufacturing Equipment and Technology, Huazhong University of Science and Technology, Wuhan 430074, Hubei, China.



Introduction

- Optical scatterometry is one of the most important techniques for measuring nanostructures due to its inherent nondestructive, noncontact, time-effective, and relatively inexpensive merits over other metrology techniques.^[1]
- A novel instrument called the tomographic Mueller-matrix scatterometer (TMS) is developed to collect the rich scattering information for nanostructure metrology.^[2]

Principle of the TMS

TMS combines a dual rotating-compensator Mueller matrix ellipsometer with a high-NA objective lens.

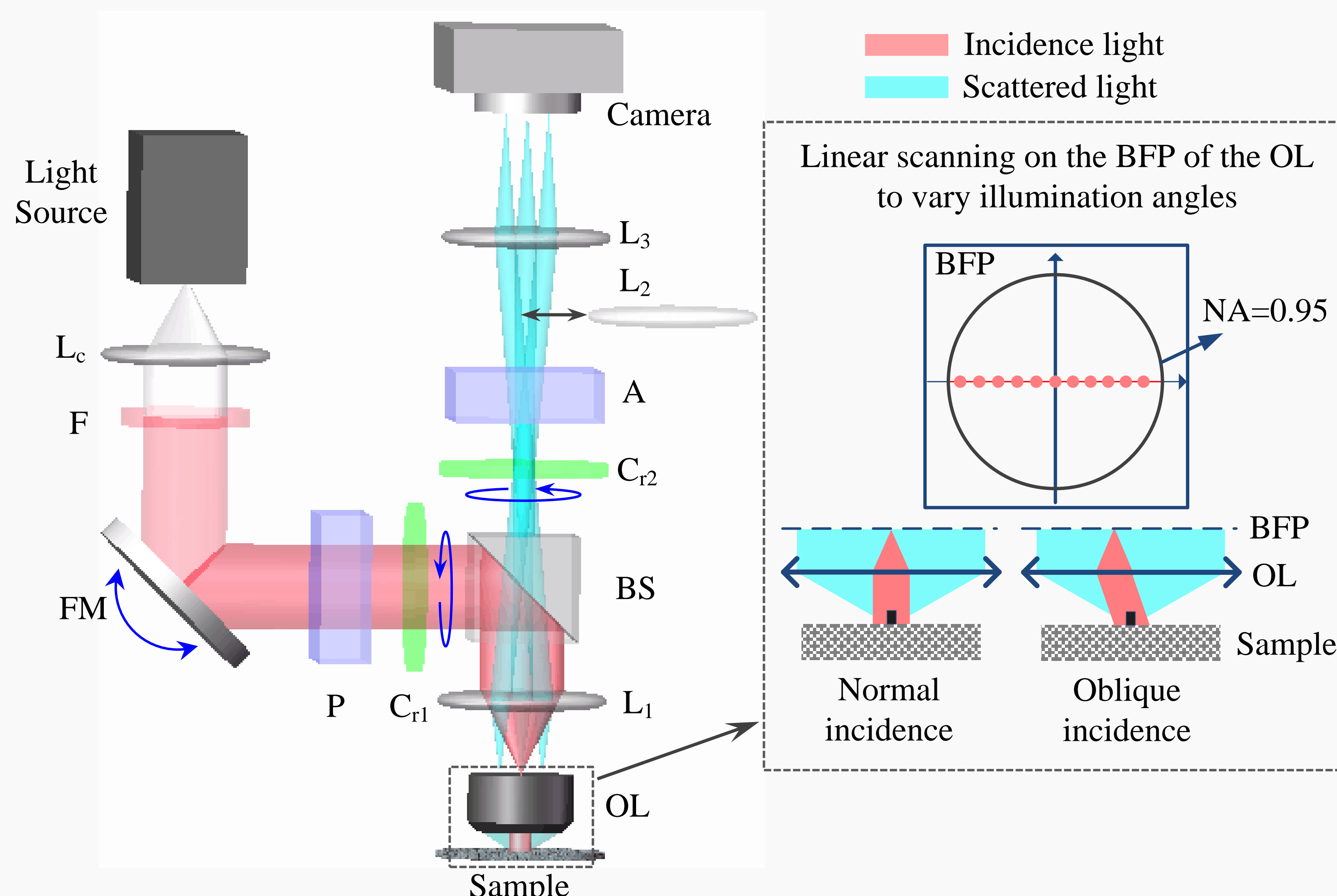


Figure 1. Scheme of the developed TMS. L_c , collimating lens; F, filter; FM, flat mirror; P, polarizer; Cr_1 , the 1st rotating compensator; Cr_2 , the 2nd rotating compensator; A, analyzer; L_1 , L_2 , L_3 , relay lenses; OL, objective lens.

Samples

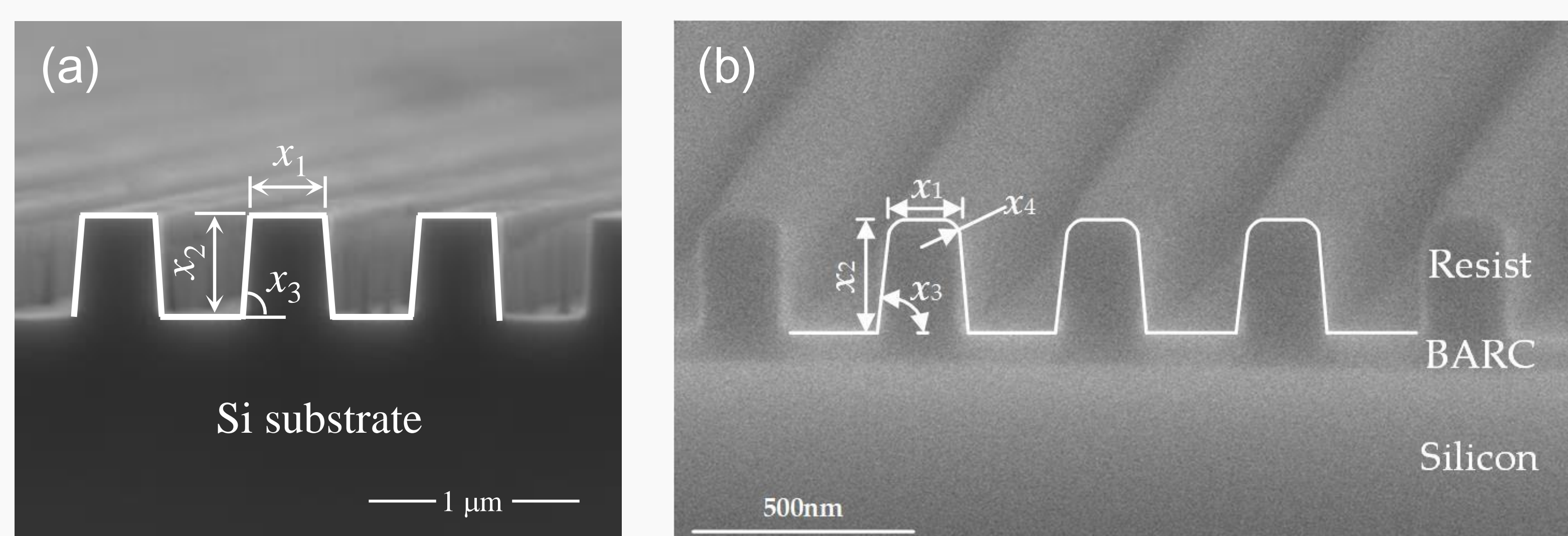


Figure 2. SEM micrographs and geometric models of the investigated (a) Si grating and (b) photoresist (PR) grating.

Nanostructure metrology by TMS

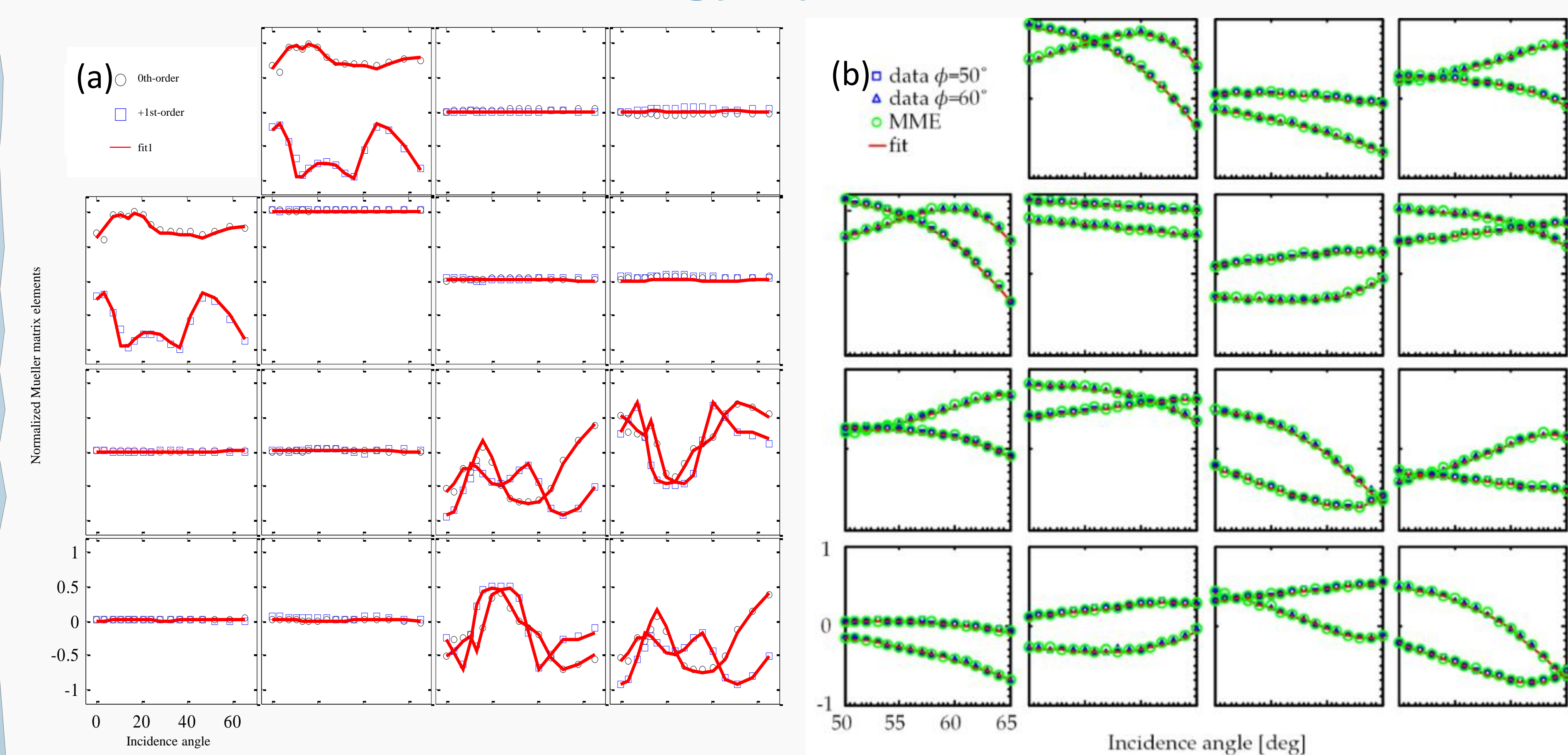


Figure 3. Measured Mueller matrices and fitting results of (a) Si grating and (b) PR grating.

Table 1. Comparison of the fitting parameters of the Si and PR gratings extracted from TMS and SEM measurements

Parameter		SEM		TMS	
Si grating	PR grating	Si grating	PR grating	Si grating	PR grating
x_1 (nm)	x_1 (nm)	350	203.4	348.8	204.2
x_2 (nm)	x_2 (nm)	472	303.7	473.4	295.8
x_3 (deg)	x_3 (deg)	88	89.5	87.2	89.2
	x_4 (nm)				54.3

Conclusions

- The results have exhibited good agreement with calculated values.
- The experiments performed on several periodic nanostructures (Si gratings, PR gratings) has preliminarily demonstrated the great potential of TMS.

References

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2. Y. Tan, C. Chen, X. Chen, W. Du, H. Gu, and S. Liu, "Development of a tomographic Mueller-matrix scatterometer for nanostructure metrology," *Rev. Sci. Instrum.* **89**, 073702 (2018).

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