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A preliminary test of two-dimensional neutron grating interferometer

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1. Introduction

The grating based neutron imaging is one of advanced neutron imaging techniques, and one-dimensional (1D) grating based neutron imaging has been mainly researched [1-4]. However, neutron imaging with 1D neutron grating interferometer can give only one-directional information. To overcome this limitation, we designed and fabricated a two-dimensional (2D) neutron grating interferometer that is composed of source grating, phase grating and analyzer grating. The schematic of the 2D neutron grating interferometer is shown in Fig. 1, and the performance of 2D neutron grating interferometer was tested.

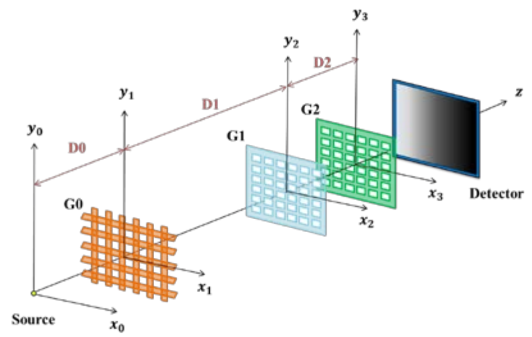

Fig. 1. The schematic of 2D neutron grating interferometer

2. Methods and Results

2.1 Cold neutron imaging facility (NG6)

2D neutron grating interferometer was prepared and tested at cold neutron imaging facility (NG6) of National Institute of Standards Technology (NIST), as shown in Fig. 2 [5]. 2D grating based neutron imaging system is composed of two components: neutron imaging system and 2D neutron grating interferometer. Neutron imaging system at NG6 consisted of a LiF neutron scintillator and lens coupled scientific CMOS camera that is made up of 2560x2160 pixels with 6.5 μm pixel pitch; the lens was a Nikon 50 mm with f1.2 [6]. Moreover, a double crystal monochromator was used to produce a monochromatic neutron beam.

Fig. 2. The established 2D neutron grating interferometer at NG6

2.2 2D neutron gratings

2D neutron gratings were designed when considered symmetry geometry and fabricated using gadox filling method [5]. Design parameters of 2D source, phase and analyzer grating are shown in Table 1, and optical microscopy images of the fabricated silicon grating surface are shown in Fig. 3. The fabricated silicon gratings for source and analyzer grating were filled with Gadox particles.

Table I: Design parameters of 2D gratings

				CASE 1	CASE 2
	wavelength		A	2.74	4.4
Pitch	Source grating(G0)	P0	um	50	50
	Phase grating(G1)	P1	um	50	50

	Analyzer grating(G2)	P2	um	50	50
Height	Source grating(G0)	H0	um	100	100
	Phase grating(G1)	H1	um	55.39	34.39
	Analyzer grating(G2)	H2	um	100	100
Distance	G0 to G1	D1	m	2.315	1.42
	G1 to G2	D2	m	2.315	1.42
Duty cycle	Source grating(G0)	f0		0.25	0.25
	Phase grating(G1)	f1		0.5	0.5
	Analyzer grating(G2)	f2		0.5	0.5

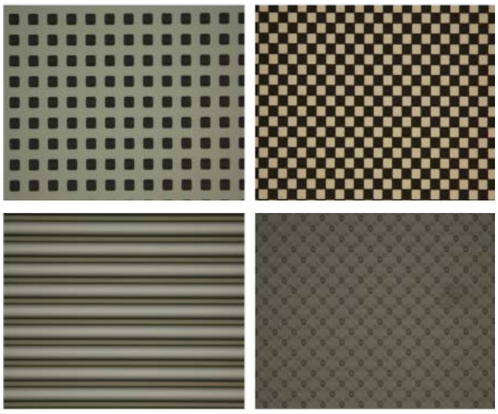

Fig. 3. Optical microscopy images of the fabricated silicon grating surface

2.3 Neutron imaging with 2D gratings

Neutron dark-field and transmission image of samples were obtained as shown in Fig. 4. We can see the contrast differences owing to the neutron scattering by sample property.

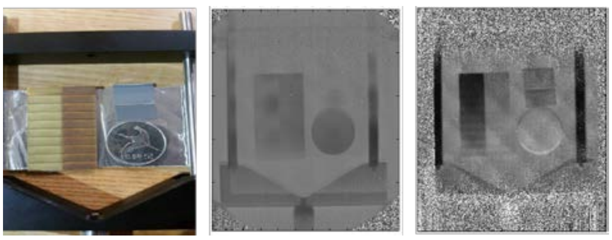

Fig. 4. Neutron transmission (middle) and dark-field (right) image of samples (step wedge, electric steel, and coin)

3. Conclusions

We confirmed that the prepared 2D neutron grating interferometer was working well at NG6, and could obtain neutron dark-field imaging using phase stepping process. The 2D neutron grating interferometer setup will be performed and evaluated at the imaging facility of HANARO and applied to material science.

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[6] Certain trade names and company products are mentioned in the text or identified in an illustration in order to adequately specify the experimental procedure and equipment used. In no case does such identification imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the products are necessarily the best available for the purpose.

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