実験報告書様式（一般利用課題・成果公開利用）

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# Experimental Report	承認日 Date of Approval 2017/6/26 承認者 Approver Takenao Shinohara 提出日 Date of Report 2017/6/1
課題番号 Project No. 2016A0262 実験課題名 Title of experiment Development of grating based phase imaging technique using pulsed neutron beam 実験責任者名 Name of principal investigator Takenao Shinohara 所属 Affiliation J-PARC Center, Japan Atomic Energy Agency	装置責任者 Name of Instrument scientist Takenao Shinohara 装置名 Name of Instrument/(BL No.) RADEN/BL22 実施日 Date of Experiment 2016/05/15 09:00～2016/05/18 09:00 2016/12/7 21:00～2016/12/10 21:00

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

Ti rod, Al rod, Pb rod, V rod, Fe rod, Ni rod

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）

Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

The phase imaging setup using Talbot-lau interferometry system was constructed at the upstream sample position of the RADEN instrument. The illustration of experimental setup is shown in Fig. 1. Three gratings (G0, G1, G2) are placed in a proper distance and each grating position was finally decided to maximize the visibility of moire pattern obtained by the neutron 2D detector using EMCCD camera. At first, we tested 5 G2 gratings which are made by the oblique evaporation technique of Gd. According to the previous test experiment, we can evaluate both the effective thickness of Gd layer and approximate duty cycle of grating from the wavelength dependent neutron transmission. Then, we selected a G2 grating which had highest visibility and good spatial homogeneity and used to the following phase imaging experiments.

The obtained image without sample shown in Fig.2 (left) indicates clear moire fringe pattern. Change in the visibility of moire pattern against the neutron wavelength was studied and we found that moire pattern appeared almost whole wavelength range from 1.5 to 8.5 Å and the maximum visibility was obtained at the wavelength of 5 Å, which was the designed value of present phase imaging apparatus (Fig. 2 (right)).

2. 実験方法及び結果（つづき） Experimental method and results (continued)

In addition, at the wavelengths, which are half-integer of optimal wavelength, the visibility became about the half of maximum value. This agreed well with the expectation from the Talbot-Lau condition. This result clearly indicated the availability of broad wavelength range neutron beam for neutron phase imaging.

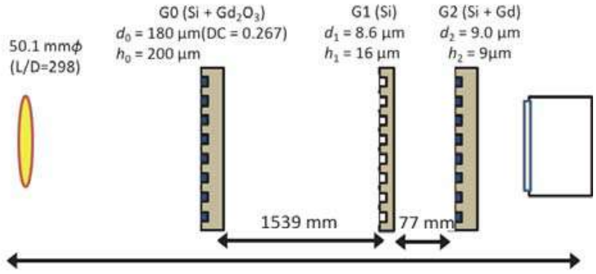

Fig. 1 Illustration of the experimental setup of neutron phase imaging. Three gratings are placed with a proper spacing, and 2D neutron detectors of both camera-type and counting –type were used for the experiment.

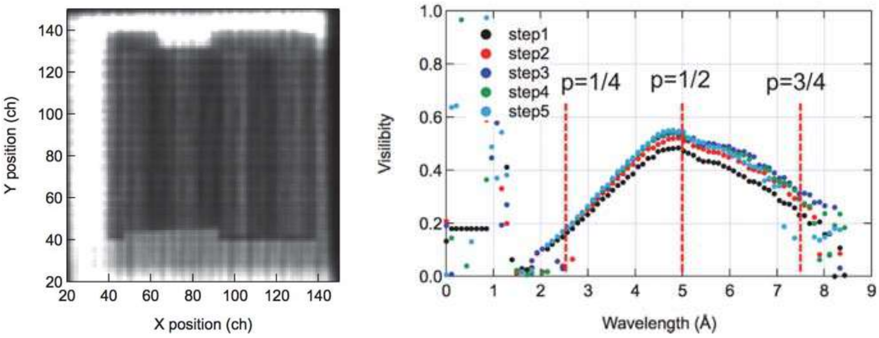

Fig. 2 right: observed moire pattern without sample, left: wavelength dependence of visibility. The value p indicates Talbot-order.

Then, we placed several metal rods in front of the G1 grating as the sample, and performed fringe-scan to obtain absorption image, differential phase image, and visibility image as shown in Fig. 4. It is obviously found that Al rod can be clearly seen in the differential phase image while it was not recognized in the absorption image. Moreover, the difference in the sign of scattering lengths between Al and Ti was observed as the change in the distribution of φ.

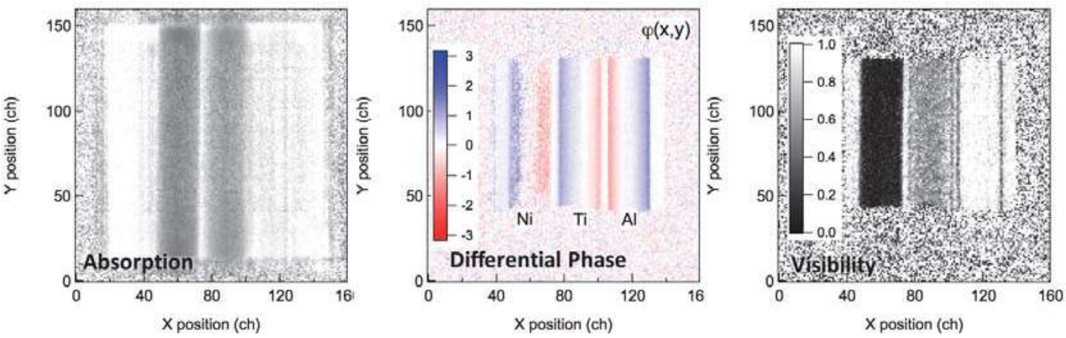

Fig. 3 obtained images with metallic rod samples. Right: absorption image, center: differential phase image, and left: visibility image at the wavelength of 4.3 Å.

The wavelength dependence of differential phase distribution, we could confirm that φ was proportional to the square of wavelength and that φ was wrapped when it went over 2π. This result indicates that by means of analyzing wavelength dependence of differential phase j makes it possible to unwrap the phase shift and to evaluate spatial distribution of phase information precisely.