Characterization of Zone Plate for Focusing X-ray

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1. Introduction

Utilizing a long beam line planned in SPring-8, the subgroup 'Very Small Angle X-ray Scattering' (VSAXS) is going to construct a 1000m-long VSAXS camera. During the feasibility study in the past several years, it has been required to characterize the focusing ability, thermal stability against heat load and parasitic scattering of optical devices, i.e. refractive lenses and zone plates, which have been proposed to be used in the camera. Here, we report the first experiment on the thermal responce of dummy zone plates irradiated by the strong light from a SPring-8 undulator (BL47XU) and the focusing ability of a zone plate.

2. Experimental

The experiment was performed in experimental hutch 2 of beam line BL47XU; the storage ring was operated at 8GeV and 20mA. The wave length selected by a monochromator was typically 0.154nm, and 0.77nm was also used. The zone plate is made of a gold film 5 μm in thickness on a beryllium disc 1mm thick. The most contribution of heat load caused by the absorption of X-rays will come from the gold film, and hence we prepared an alumel-chromel thermocouple sandwiched by 'dummy zone plates' of two gold films 5 μm or 10 μm thick. We can thereby measure the temperature of the gold films (dummy zone plate) during the irradiation of X-ray. A perfect crystal of silicon 0.5mm thick was mounted on a precision goniometer controlled by a pulse motor controller (Tsuji Denshi PM16C-02N). With an ion chamber (Oken S-1194B) and a pico-ammeter (Keithley 428) connected to an analog recorder, rocking curves of the silicon crystal were measured for two cases: for a bare incident beam and an incident beam through the zone plate. we compare the two cases to characterize the focusing behavior.

3.Results

Firstly, the temperature rise of the gold plates during the irradiation was found to be less than 0.1℃ for both the wave lengths of 0.154nm and 0.077nm. We can therefore examine the focusing ability of a true zone plate without worrying about the thermal instability which might have been caused by the irradiation. Figure 1 shows a rocking curve for Laue case (220 reflection) for bare incident X-ray and an incident beam through the zone plate. We can see the diversing ray supposedly due to the first focus of the zone plate. It has been therefore shown that the focusing behavior of the zone plate can be characterized by the rocking curves and better crystals are required for the quantitative analysis.

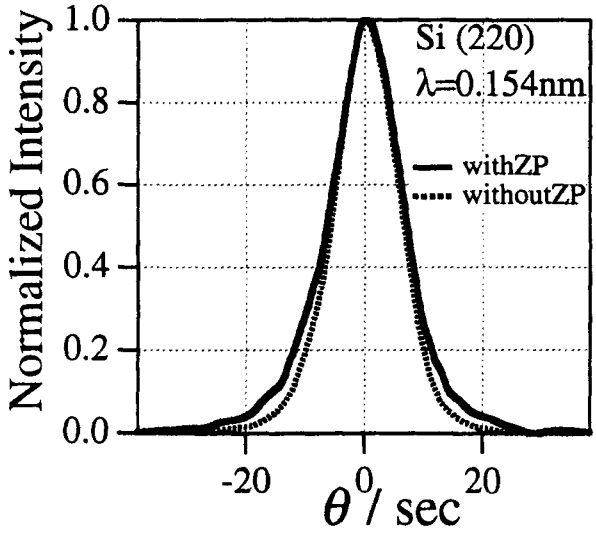

Fig.1. Rocking curves of Si (220 reflection).