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Pure Measurement of Multiple Energy X-ray Holography

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Introduction

In X-ray fluorescence holography (XFH), angular distributions of the fluorescent X-rays are measured. On the other hand, in multiple-energy X-ray holography (MEXH), dependences of the fluorescence yield on incident X-ray directions are measured. For both XFH and MEXH, the fluorescent X-rays are detected. As a result, measured holograms are usually a mixture of XFH and MEXH information, because processes of XFH and MEXH always occur simultaneously in the case where monochromatic X-rays are used to excite fluorescent X-rays. It is, however, possible for both XFH and MEXH to realize pure measurements experimentally [1, 2]. For pure XFH, the sample is to be fixed with respect to incident X-rays and the detector is to be rotated around the sample [3]. For pure MEXH, a detector has to be kept constant with respect to the sample [4], or analyzing crystals have to be symmetrically arranged with respect to sample surface normal. Otherwise, the fluorescent X-rays should be collected over 4π solid angle for pure MEXH [5].

In the present work, analyzing crystals and diffractometer were designed and fabricated for pure measurements of MEXH and pure MEXH was studied using Ge(111) single crystal.

Experimental

The experiment was performed at the vertical wiggler station BL-14B in the Photon Factory. The sample was Ge(111) single crystal. The energy of incident X-rays was selected to be near Ge K-absorption edge by the Si(111) double crystal monochromator. The intensity of incident X-rays was monitored by an ionization chamber. The variations of GeKα yield emitted by Ge (111) single crystal were measured as a function of incident directions. An avalanche photo-diode was used for detecting GeKα yield. In front of the detector, Analyzing crystals were placed to suppress unwanted radiation. Through the measurements, the analyzing crystals were symmetrically arranged with respect to sample surface normal.

Results

Figure1 indicates the hologram pattern obtained by rotating the sample with respect to polar and azimuthal angles. In the figure, backgrounds corresponding to reference intensities were subtracted and the hologram pattern was normalized by the reference intensities. The pattern shows three-fold symmetry.

Using present data set, three-dimensional images of atomic arrangements are compared with calculations and analyzed in detail.

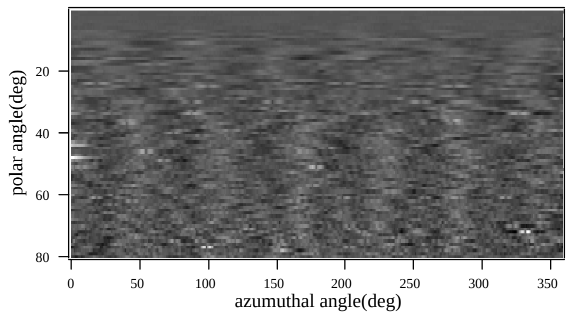

Fig. 1. Hologram pattern obtained for Ge(111) single crystal by rotating the sample with respect to polar and azimuthal angles.

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