X-ray fluorescence holography of Zn in GaAs:Zn

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The X-ray fluorescence holography makes it possible to obtain direct three-dimensional atomic images around atoms emitting fluorescent X-rays. However, only the holograms of single crystals, whose atomic configurations are already known by X-ray diffraction method, have been measured because of the weakness of the primary X-rays. Therefore, we applied this method to image the atmic structure around zinc (Zn) atoms doped in gallium arsenide (GaAs) using synchrotron radiation.

In order to remove the X-ray fluorescence of Ga and As, the incident X-ray energy was controlled at 9.8 keV, which was between the Zn and Ga K absorption edges. The Zn Kα X-ray fluorescence intensity was measured as a function of azimuthal and polar angles of a detector, and the resulting holographic pattern was obtained. A real space atomic image was obtained by Fourier transformation from the hologram. The reconstruction in Fig.1 is an environment of Zn atom on (001) plane. Four nearest neighbor atoms of the central emitter clearly appear in the image at distance of 4.0 Å from the center. The crystal structure of GaAs can be conveniently described in a ZnS like structure with a = 5.65 Å, that is, it consist of two face centered cubic cells. The Ga and As layers stack alternately along c axis. The atomic configurations in the Ga and As layers are equivalent and the nearest neighbor Ga-Ga or As-As distance is 4.00 Å. Thus, it is clear that the Zn atoms substituted for Ga and/or As host atoms from the reconstructed image. The presented results demonstrate that the X-ray fluorescence holography technique is applicable to practical chemical analysis of trace impurities for reasonable measurement time using 3rd generation synchrotron-radiation.

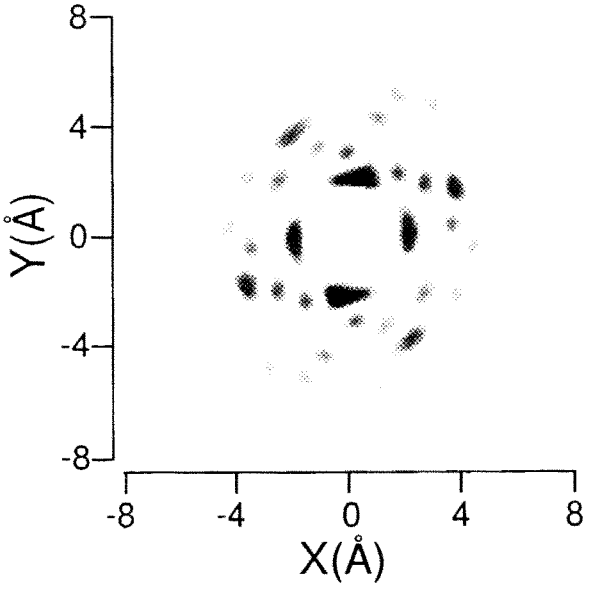

Fig. 1 X-ray fluorescence hologram of Zn in GaAs:Zn