Atomic Image around Mn Atoms in Diluted Magnetic Semiconductor Zn\(_{0.4}\)Mn\(_{0.6}\)Te Obtained by X-ray Fluorescence Holography

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Recently, diluted magnetic semiconductor Zn\(_{1-x}\)Mn\(_x\)Te has attracted much attention as a spintronic material. From an X-ray diffraction [1], the lattice constant of Zn\(_{1-x}\)Mn\(_x\)Te linearly changes with varying \(x\) (Vegard’s law), while an XAFS results [2] showed almost unchanged Mn-Te and Zn-Te bond lengths (Pauling’s rule). This discrepancy led to a question of how the large MnTe\(_4\) tetrahedra can be squeezed into the small ZnTe\(_4\) lattice.

X-ray fluorescence holography (XFH) is a new technique that allows one to investigate a three-dimensional local image around a specific element. The sample was irradiated by intense X-rays of certain energies beyond the Mn-K absorption edge at BL37XU/SPring-8 in order to obtain the Mn-K fluorescence hologram [3]. A three-dimensional atomic image around the Mn central atoms was derived from the holograms using Barton’s algorithm, as shown in Fig.1. The nearest- and third-nearest-neighbor Te atoms are clearly visualized. However, the second-nearest-neighbor Zn or Mn atoms are barely visible in this image due probably to a highly distorted cation Zn(Mn) sub-lattice.