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Inside source x-ray fluorescent holography on NiO

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Atomic resolution x-ray holography can be realized by using the atoms of the sample as inside sources [1,2] or as inside detectors [3]. However, until now there were only very few experiments in which the atoms played the role of inside sources. The reason is twofold: (*i*) technically, inside detector experiments are much easier; (*ii*) using atoms as inside detectors one can measure holograms at many energies on the same sample, which helps the reconstruction process. In this work we show that using new technical developments, inside source holograms can be taken much faster (within 1 second at a synchrotron source) than inside detector holograms and applying a sophisticated evaluation method high quality reconstruction from a single energy hologram can also be obtained. The adaptation of this technique to XFEL-s opens a series of new possibilities in structural studies. For example, one can obtain 3D structural information of very short lived transient structures, appearing in highly non-ambient conditions: high pressure, high magnetic fields, high temperatures, where experimental conditions cannot be repeated with exact control.

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Local structure observation of Sm doped RB_6 (R: rare earth)by white neutron atomic resolution holography

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Physical properties of materials are often controlled by impurity doping. Thus, understanding the local structures such as distorted structures around the dopant is important to clarify origins of the properties. However, such local structures cannot be observed by diffraction because there is no translational symmetry.

Recentry, atomic resolution holography using x-rays and photoelectrons has been depeloped, which can observe local structures around dopants in the range of 20 Å of three-dimensional area. Thus, atomic resolution holography is the best probe to investigate local structures.

On the other hand, it is difficult to observe light elements such as H, B or O by x-rays and photoelectrons. Therefore, we have developed atomic resolution holography using white neutrons, which are sensitive to light elements, at Japan-Proton Accelerator Research Complex at Tokai Japan [1]. We have already succeeded in visualising local atomic structure in B doped Si, which is the most important semiconductor, and Eu 1% doped CaF_2, which is a typical scintilation crystal. For CaF_2, we found that there exist excess F around doped Eu [1]. Based on this success, we are trying to apply this novel technique to various fields of materials science.

In this study, we focus on a strongly correlated electron system RB_6 (R: rare earth). When Sm is doped in LaB6 and YbB6, it behaves as Sm^{2+} in the former and as Sm^{3+} in the latter [2]. We expect that the difference of local structures around Sm may play a role in this change of valency. White neutron holography experiments were performed on a single crystal $La^{11}B_6$ and $Yb^{11}B_6$ with 2% doped Sm. We succeeded in reconstruction of the local structure of R around Sm using data in the neutron energy range from 10 meV to 200 meV. We confirmed that R around the Sm dopant are located at the same positions as in pure RB_6, meaning that Sm doping does not effect R structure. Moreover, we also succeeded in reconstruction local structure of ^{11}B viewed from Sm. These results indicate that neutron atomic resolution holography is an effective probe for investigations of local structures even for various materials which include light elements.

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