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Low-temperature X-ray ellipsometry with a liquid-helium cryostat

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Introduction

We have developed a universal X-ray ellipsometer which consists of an X-ray polarizer, aberration-free multiple phase retarders [1] and an analyzer. It enables us to create an X-ray beam having a high degree ($P > 0.98$) of linear, circular or other polarization state in the X-ray region. It also enables us to analyze precisely the polarization states of the beam transmitted or diffracted by the specimen. The available X-ray energy range is 6-18 keV. With this system, we could measure NLD, NLB, NCD, NCB, MCD and MCB (Natural or Magnetic, Circular or Linear, Dichroism or Birefringence) at room temperature in the X-ray region.

Many of interesting materials cause magnetic phase transition at low temperature. For example the cyano-bridged 3d-4f heterobimetallic assembly $Nd(DMF)_4(H_2O)_3(\mu\text{-}CN)Fe(CN)_5{\cdot}H_2O$ (DMF = N, N-dimethylformamide) cause photoinduced magnetization less than 50 K [2]. The photoinduced magnetization of the Prussian blue is explained by the charge-transfer mechanism. However, the photoinduced magnetization of the 3d-4f heterobimetallic assembly isn't cannot be explained by the charge-transfer mechanism according to by Mossbauer spectra. As for this phenomenon, it is predicted that an angle change of cyano combination is would be related by single crystal structure analysis.

Therefore we introduced a liquid-helium cryostat into a universal X-ray ellipsometry and aimed to analyze the photoinduced magnetization of a 3d-4f heterobimetallic assembly by NLD (polarized XAFS) and MCD by introducing a liquid-helium cryostat into a universal X-ray ellipsometry .

Development and Experimental

The liquid-helium cryostat for X-ray topography has beenwas designed and manufactured (Fig. 1) [3]. The cryostat is able to cool a sample from room temperature to 4.2 K. The superconducting magnets were constructed in the cryostat, in which the directions of the magnetic fields generated by a set of 3 independent coils was goniometrically controlled by 3 bipolar sources. The maximum magnetic field is nearly equal to about 0.86 T. We placed an optical fiber in the cryostat to irradiate a sample with ultraviolet or visible rays to a sample. We have measured the spectra of the NLD at Fe K-edge (7112 eV), Nd L2-edge (6722 eV) and Nd L3-edge (6208 eV) with a 3d-4f heterobimetallic assembly single crystal at room temperature as the preliminary measurements. But, so far we We have not yet measured weren't able to experiment them at the low temperature for because of leak trouble of vacuum.

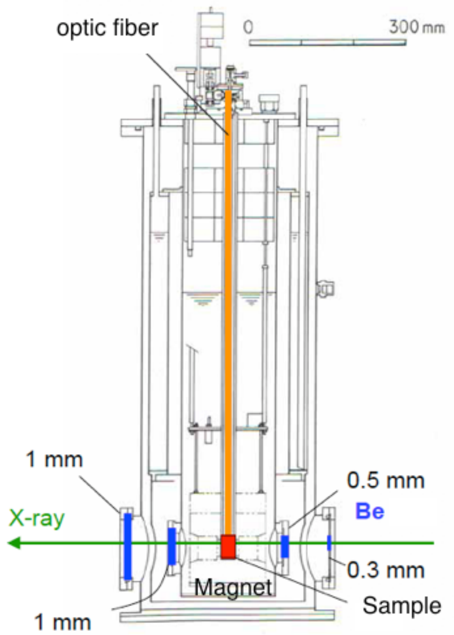

Fig. 1 The liquid-helium cryostat

Results and discussions

We introduced a liquid-helium cryostat into a universal X-ray ellipsometry. But, we weren't able to experiment at the low temperature for leak trouble of vacuum. We have measured the spectra of the NLD at Fe K-edge, Nd L2-edge and Nd L3-edge with a 3d-4f heterobimetallic assembly single crystal at room temperature.

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Reference

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