Local Structure and Magnetic Property for Hard Magnetic Material $Sm_2Fe_{17}N_x$

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1. Introduction

In 1990, the intersititally modified compound $Sm_2Fe_{17}N_3$ was discovered by applying the gas-phase interstitial modification technique to Sm_2Fe_{17}. The Curie temperature T_C increases dramatically from 398K to 752K. The saturation magnetization and the uniaxial magnetic anisotropy are, also dramatically, changed. The crystal lattice of Sm_2Fe_{17} expands more than 6% to accommodate three nitrogen atoms at the interstitial sites. It is suggested that these interstitial sites are the around the Sm-atoms. It is thought that these interstitial nitrogen atoms cause displacements of the metal atoms from their regular sites, and the resulting crystal lattice distortion give rise to various kinds of the above-mentioned changes.

X-ray Absorption Fine Structure (XAFS) is one of the appropriate technique to study the local structure. Especially, the radiation spectrum from a bending magnet at the SPring-8 storage ring has the sufficient photon density to measure the high energy X-ray regions. In order to clarify the change of the local structure around the Sm-atom by absorption of the N-atom, XAFS studies of the Sm:K-edge in Sm_2Fe_{17} and $Sm_2Fe_{17}N_3$ compounds were measured at room temperature.

2. Experimental and Results

XAFS spectra near the K-edge of Sm (46.834keV) in Sm_2Fe_{17} and $Sm_2Fe_{17}N_3$ compounds were measured at BL01B1 of SPring-8. Measurements were carried out in transmission mode with Si(511) planes of an adjustable inclined double-crystal monochromator. The incident and transmitted x-ray intensities monitored with ionization chambers with Kr-gas. The estimated energy resolution was about 4eV by using the slit.

3. Results

Observed XAFS spectra are shown in Fig.1. The difference in region of the XANES, especially, the just behind the edge jump, was observed. This difference was caused by the change of the environment of the electric state of Sm-atom by the absorption of the N-atoms.

The local structure was, also, exchanged by the absorption of the N-atoms. The distance of the Sm-atom and the Fe-atoms (18f, 6c, 18h and 9d sites) were expanded, and the distance of the Sm-atom and N-atom was 2.591Å. It is thought that this change of our observed local structure is relation with the magnetovolume effect.

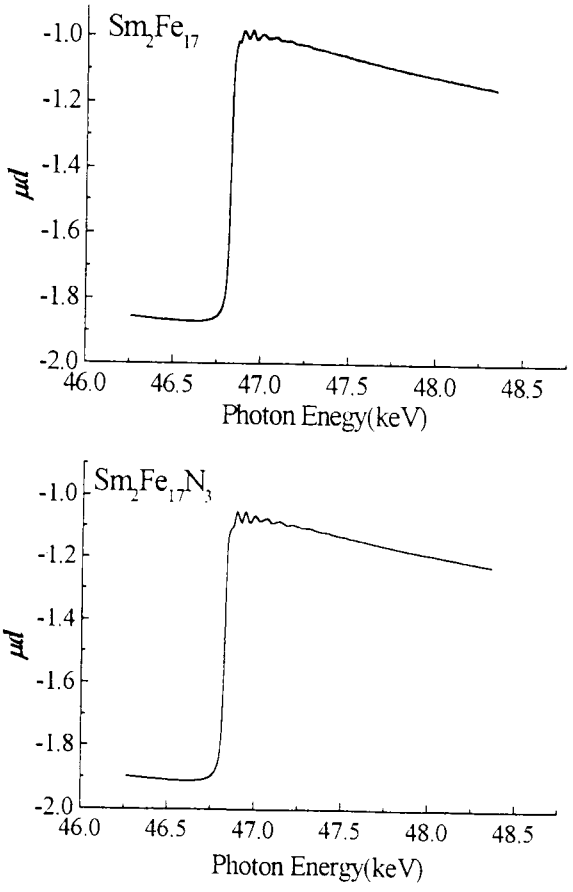

Fig.1 Observed XAFS spectra of Sm_2Fe_{17} and $Sm_2Fe_{17}N_3$ compounds