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Sm $M_{4,5}$ core level XMCD studied by circularity switching method for zero-magnetization ferromagnet (Sm, Gd)Al_2

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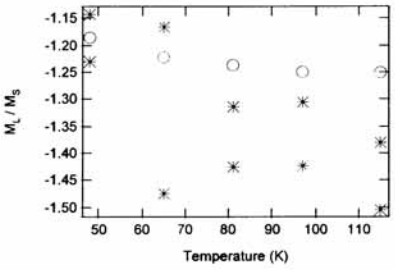
(Sm,Gd)Al_2 is expected to be a ferromagnetic material with zero net magnetization[1] because the cancellation between spin and orbital magnetic moments at a certain compensation temperature, T_{comp}. Our previous X-ray magnetic circular dichroism, XMCD, studies (proposal No. 2002A0493 and 2002B0681) confirmed the ferromagnetic order for both spin and orbital magnetic moments at T_{comp}. To study the mechanism of the cancellation, the temperature dependence of spin and orbital magnetic moments needs to be studied. Because the very small net magnetism of this sample, the normal magnetic field switching methods is invalid and the MCD was measured by the difference of absorptions of two scans, that after the first scan, the circular polarization was inverted in the second scan. Our results show that the magnitude of the ratio of total orbital to spin magnetic moment $|M_{LT}/M_{ST}|$ increases along with the decrease of temperature, whereas the magnitude of ratio for Sm 4f electrons, $|M_L/M_S|$, was found unchanged or decrease as shown by the star marks in the figure. We can see the experimental error is not small enough. In this work, we did the experiment by switching the circularity of photons in every data point to avoid the experimental error related with the long time period between the two scans and the result is shown in the figure by open circle marks. We can see clearly that the magnitude of $|M_L/M_S|$ decreases with the decrease of temperature.



[1] H. Adachi and H. Ino, Nature **401**, 148(1999).

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Soft Xray Photoemission Spectroscopy of Clathrates with Controlled Dimensionality

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The most famous materials in polyhedral network cluster solids are Si_{46} and Ge_{46}, whose fundamental building blocks are two dodecahedra and six tetrakaidecahedra, so called as type I structure. Other than this crystal structure, sixteen dodecahedra and eight hexakaidecahedra of Si and Ge create Si_{136} and Ge_{136} lattice and the other form is Si_{100} and Ge_{100} that have chiral structure consisting of Si and Ge dodecahedra with open cage structure. Dimensionality can also be controlled when the 3rd group elements like Al are used. One of the most typical such ternary compounds is Ba-Al-Si that is reminiscent of the MgB_2 structure, where two-dimensional network is realized.

We have encountered, in the type I clathrates, the evidence that the Si and the Ge networks reveal different electronic states: Ba-doped Si_{46} is metallic and superconducts at 8 K, while Ge_{46} one is semiconducting. Actually, the latter feature has been understood by the fact that the strain of the network, due to the larger ionic size of the Ge element, leads to the deficient occupation of Ge atoms at the crystallographic 6 c site. In the present study, we have studied the third type structure for both Ba-doped Si_{100} and Ge_{100} compounds and known that the both have completely the same crystal structure. However, at the same time, they have very different electronic properties, the former being a good metal and the latter showing an intriguing electronic phase transition.

It is very crucial to understand how such difference in their electronic states comes out. For this purpose, we have employed soft X ray spectroscopy using a high energy facility of Spring-8. The temperature dependences near the Fermi surface clearly show that a large decrease in the density of states at the Fermi level occurs going from high temperature to low temperature in the case of $Ba_{24}Ge_{100}$, while no change in the case of $Ba_{24}Si_{100}$.