X-ray Absorption Spectroscopy and X-ray Magnetic Circular Dichroism studies of ferrimagnetic $Gd_6(Mn_{1-x}Co_x)_{23}$

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Abstract :

We study the electronic structure of the intermetallic series $Gd_6(Mn_{1-x}Co_x)_{23}$, x = 0.0 – 0.3, which shows a decrease in ferrimagnetic transition temperature T_c = 489 K for x = 0.0, down to T_c = 118 K, for x = 0.3 [1]. We have carried X-ray absorption spectroscopy (XAS) and X-ray magnetic circular dichroism (XMCD) studies of the series $Gd_6(Mn_{1-x}Co_x)_{23}$, x = 0.0, x=0.2 and x= 0.3 at the Dragon beamline of the Taiwan Light Source. Model calculations are also employed to determine the valence states of Gd, Mn and Co in the series. The similarity of the Mn L-edge, Co L-edge and Gd M-edge XAS spectra for all compositions confirm that the electronic states of Mn, Co and Gd ions do not change in the series $Gd_6(Mn_{1-x}Co_x)_{23}$. We could also obtain clear XMCD spectra of the Gd ions in the series which indicates nearly full Gd^{3+} spin magnetic moment of the Gd $4f^7$ configuration with S = 7/2 state. The Co L-edge XMCD spectra for x = 0.2 and x = 0.3 show that the Co magnetic moments are antiferromagnetically coupled to the Gd magnetic moments. Further, the intensity of Co L-edge XMCD spectrum at x = 0.3 indicates a larger magnetic moment than at x= 0.2, indicating the role of Co substitution in reducing the net magnetization and decrease in the ferrimagnetic Tc. We also report the XMCD spectra of Gd for x = 0.3 (T_c = 118 K) as a function of temperature at 25 K, 100 K, and 150 K. The results show a systematic decrease of XMCD on increasing temperature and negligible XMCD at T = 150 K.

Reference :

[1] Pierric Lemoine, Anne Vernière, Bernard Malaman and Thomas Mazet, Journal of Alloys and Compounds 680, 612 (2016).