

Exchange Interactions in $Y_3Fe_{5-x}Cr_xO_{12}$ Fabricated by a Sol-Gel Method

Young Rang Uhm, Sam Jin Kim, and Chul Sung Kim

Abstract—The Cr-containing YIG we examined, and the exchange interactions and site distributions were studied by ^{57}Fe Mössbauer spectroscopy. The exchange parameters for $Y_3Fe_{4.5}Cr_{0.5}O_{12}$ were $J_{ad} = -52.23 k_B$, $J_{aa} = -27.85 k_B$ and $J_{dd} = -39.16 k_B$, and their values become larger as the amount of Cr decreases in garnet. The results show that chromium in $Y_3Fe_{5-x}Cr_xO_{12}$ compounds ($x = 0.0, 0.25, 0.5, \text{ and } 1.0$) occupy octahedral sites. The lowering of magnetic ordering temperature results from replacing Fe^{3+} by Cr^{3+} in the octahedral sites. Mössbauer spectra can be analysed using 3 or 4 sets of six Lorentzians with increasing amount of Cr^{3+} . It results from the distribution (${}_4C_n$) of Fe^{3+} and Cr^{3+} at octahedral sites. The ratios of areas, a, d_1, d_2, d_3 , in $Y_3Fe_{4.5}Cr_{0.5}O_{12}$ are 0.33, 0.22, 0.28, 0.14, respectively.

Index Terms—Cation distribution, exchange interactions, garnet.