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The crystallographic and magnetic properties of single phase garnet $Y_{3-x}R_xFe_5O_{12}$ (R=La, Nd, and Gd)

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The crystallographic and magnetic properties of single phase garnet $Y_{3-x}R_xFe_5O_{12}$ (R= La, Nd, and Gd) were studied using x-ray diffraction, Mössbauer spectroscopy, and vibrating sample magnetometer (VSM). The lattice constants increase when substituting rare earth ions of Nd and Gd in YIG. The Curie temperature was slightly increased when substituting rare earth ions such as Gd, Nd and La, with a relatively larger ionic radius than those of Y. It is known that Y^{3+}cation consists of inert krypton core with the 4p (no f-electron) layer fully filled with six electrons of paired spin. So, it has no permanent magnetic moment (0 μB). However, both $Nd^{3+}$and Gd^{3+}ions have a magnetic moment. The ionic radius doped in 24(c) site have a more immediate and vital influence on the magnetization, though super-exchange interaction between 16(a) and 24(d) site is weaken due to heavy rare earth Gd^{3+}ions substituted in 24(c) site**.** At room temperature, the three sub-lattices are aligned along the [111] direction. Therefore, the net magnetic moment is following equation of $M = M_c-[M_d-M_a]$.

It is well known that the La^{3+} ion is non-magnetic same as Y^{3+} ion. However, the results of magnetic property show that the M_s is decreased. This is because the substitution of La^{3+} affects to a distortion of the 16(a) and 24(d) site to different degrees, and the length and angle of the Fe-O-Fe linkage are changed. The ionic radius doped in 24(c) site have a more immediate and vital influence on the magnetization, though super-exchange interaction between 16(a) and 24(d) site is weaken due to heavy rare earth Gd^{3+} ions substituted in 24(c) site.