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Unit Cell Dimensions of Yttrium Iron Garnets Containing Neodymium, Praesodymium and Lanthanium Ions*

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Replacement of Nd, Pr and La for Y in iron garnets was studied. The unit cell dimensions varied from 12·380 Å for $Y_3Fe_2O_{12}$ to 12·530 Å in $[YNd_2]Fe_2Fe_3O_{12}$, 12·478 Å in $[Y_2Pr]Fe_2Fe_3O_{12}$, and 12·434 Å in $[Y_{2\cdot5}La_{0\cdot5}]Fe_2Fe_3O_{12}$ for the maximum amount of the lighter rare earth ions substituted for yttrium in iron garnets.

X-ray and magnetic studies on the substitutions of the yttrium by rare earths as Gd (Anderson *et al.*, 1959) or Sm (Cunningham & Anderson, 1960), in iron garnets were published recently. The magnetic properties of Y.I.G. with a partial amount of Nd (Goldring *et al.*, 1960) or of Pr and La substitutions (Schieber, 1960; Aharoni & Schieber, 1961) were also reported. The ferromagnetic resonance of Y.I.G. crystals doped with most of the rare earth ions have been measured by Dillon & Nielsen (1960).

We have measured the unit cell dimensions of garnets with Nd, Pr and La substitutions for Y in Y.I.G. The samples were prepared according to the method described by Goldring *et al.* (1960). Powder diagrams were taken on a Guinier focusing camera of 114·6 millimeter effective radius, with Cu $K\alpha$ radiation and a nickel foil placed in contact with the film. A small amount of KCl was mixed with each sample prior to exposure, the prominent KCl lines being used for calibration on every photograph.

The cell dimensions were calculated from the measured interplanar spacings, the index of each line was found from the unit cell whose length was approximately known.

Table 1. *Edge length of unit cells in rare earth substituted Y.I.G.*

Mean error about 4 units of the last decimal place

$Y_3Fe_2Fe_3O_{12}$	12·380 Å
$[Y_{2\cdot5}Nd_{0\cdot5}]Fe_2Fe_3O_{12}$	12·414
$[Y_{2\cdot0}Nd_{1\cdot0}]Fe_2Fe_3O_{12}$	12·454
$[Y_{1\cdot5}Nd_{1\cdot5}]Fe_2Fe_3O_{12}$	12·492
$[Y_{1\cdot0}Nd_{2\cdot0}]Fe_2Fe_3O_{12}$	12·530
$[Y_{2\cdot5}Pr_{0\cdot5}]Fe_2Fe_3O_{12}$	12·427
$[Y_{2\cdot0}Pr_{1\cdot0}]Fe_2Fe_3O_{12}$	12·478
$[Y_{2\cdot5}La_{0\cdot5}]Fe_2Fe_3O_{12}$	12·434

All the lines derived from the samples listed in Table 1, (except of course the KCl calibration lines) could be indexed as reflections allowed by space group $Ia3d$–O_h^{10}, thus indicating that the samples were of a single garnet phase. This was further confirmed by taking longer exposures of these samples without added KCl.

Each edge length given in Table 1 is the average of values calculated for the respective sample. The standard deviation for each set was about 0·004 Å. No extrapolation method was considered justified as the camera gives lines for only $2\theta < 90°$.

The unit cell dimensions are also plotted in Fig. 1. Within the accuracy of the measurements a linear increase of the unit cell dimensions can be seen with the increase of the rare earth amounts substituted in

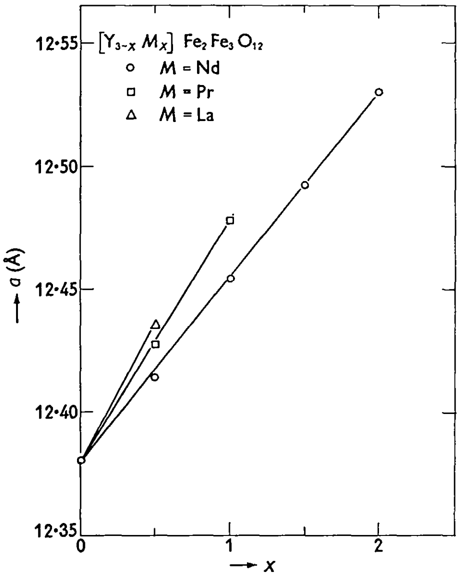

Fig. 1. Unit cell dimensions *a*, as a function of the content *x* of the rare earth ions in Y.I.G.

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the Y.I.G., as observed by Cunningham & Anderson (1960) in the Sm substituted Y.I.G. These dimensions varied from 12·380 Å in $Y_3Fe_2Fe_3O_{12}$ to 12·530 Å in $[YNd_2]Fe_2Fe_3O_{12}$, 12·478 in $[Y_2Pr]Fe_2Fe_3O_{12}$ and 12·434 in $[Y_{2\cdot5}La_{0\cdot5}]Fe_2Fe_3O_{12}$. These data were found for the maximum amount of Nd, Pr and La substituted for the Y in iron garnets. If higher proportions of these rare earths are introduced, one obtains a mixture of garnets, perovskites and in some cases also hematite. Cerium ions did not substitute for the yttrium in the iron garnets. No shift of the lines of the Y.I.G. were found in these samples and besides the garnet lines, perovskite and hematite, CeO_2 lines were also identified there. Dillon & Nielsen (1960), arrive at the same conclusion.

The cell dimensions of

$$Y_3Fe_2Fe_3O_{12} \quad \text{and} \quad [Y_{1\cdot5}Nd_{1\cdot5}]Fe_2Fe_3O_{12}$$

measured by us are in fair agreement with the data obtained by Bertaut & Forrat (1956, 1957) and Geller & Gilleo (1957).

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The Crystal Structure of the α-Form of *bis*-(N-methylsalicylaldiminato)-Copper

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The crystal structure of the α-form of *bis*-(N-methylsalicylaldiminato)-copper has been determined. The unit cell has

$$a_0 = 24\cdot71 \pm 0\cdot02,\ b_0 = 9\cdot25 \pm 0\cdot01,\ c_0 = 6\cdot66 \pm 0\cdot02\ \text{Å},$$

space group *Ibam*, and contains 4 molecules. Intramolecular distances and angles are essentially the same as those reported for the nickel compound, except that the molecule of the copper compound is completely planar and the metal-ligand distances are 0·1 Å longer. The packing of the molecules is quite similar to that found for *bis*-dimethylglyoximato-nickel and involves chains of Cu atoms with a Cu–Cu separation of 3·33 Å.

Introduction

Stackelberg (1947) described the cell dimensions and space groups of three forms of *bis*-(N-methylsalicylaldiminato)–copper, which he called α, β, and γ. Since it appeared from his results that the structure of the α-form is somewhat similar to that found by Godycki and Rundle (1953) for *bis*-dimethylglyoximato–nickel, we have determined its structure.

The determination of the structure was carried out independently in both laboratories and preliminary reports have appeared (Methuen & v. Stackelberg, 1960; Lingafelter, Morosin & Simmons, 1960). Since the results of the two determinations are in quite satisfactory agreement, and since the refinement was carried somewhat further at the University of Washington, the present report has been written in terms of that determination.

Experimental

bis-(N-methylsalicylaldiminato)–copper was prepared by the reaction between methylamine and *bis*-salicylaldehydato–copper in ethyl alcohol, and recrystal-