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Abstract

Full Text

CRYSTALLOGRAPHY

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GROWTH OF FERRITE SINGLE CRYSTALS BY THE VERNEUIL METHOD

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Studies of the properties of ferrite materials have until now been carried out mainly on polycrystalline specimens or on small crystals grown from a solution melt.

At the Institute of Crystallography of the Academy of Sciences of the USSR, ferrite single crystals have been obtained by the Verneuil method ([1,2]) in an oxygen-hydrogen flame.* For this purpose, a crystallization apparatus of the design of S. K. Popov ([3]) was used.

The starting material was a charge prepared by calcining a mixture of ferric ammonium alum and sulfate salts of divalent metals. Crystals were grown from charges containing different amounts of the oxides Mn, Co, Ni, Zn, Mg–Mn, Mn–Zn, and Ni–Zn. The crystal dimensions were: diameter up to 7-8 mm, l up to 50 mm (Fig. 1), and in individual cases up to 90 mm. The ratio $H_2 : O_2$ in the flame was then 0.7-1 by volume.

The single-crystal nature of the specimens was confirmed by x-ray and goniometric investigations. The latter showed that, under optimal conditions of spontaneous crystallization of Mn and Co ferrites, the direction of crystal growth coincides predominantly with the directions: for Mn crystals, with [111]; for Co, with [110].

The hardness of the crystals is 6-6.5 on the Mohs scale.

In order to establish the degree of homogeneity along the length, the crystals were subjected to chemical analysis. For the investigation, two Mn-ferrite single crystals $7 \times 7 \times 45$ mm in size were taken, having a composition close to stoichiometric but with a slight excess of manganese. The tops (5 mm), middle parts, and lower parts (10 mm each) of the crystals were cut off with a "diamond" saw; each piece was separately ground, and then weighed portions were dissolved in hot HCl.

Fig. 1. Mn-ferrite single crystal (natural size).

Table 1

Crystal No.	Part of crystal	Mn_3O_4, %	F^{++}, %
1	Lower	1.30	No
1	Middle	1.27	No
1	Top	Traces	No
2	Lower	1.51	No
2	Middle	1.48	No
2	Top	No	Traces

Taking into account earlier investigations ([4,5]), the analysis was limited to determining the content of Mn_3O_4 and Fe^{++}. The results of the analysis are given in Table 1 (duplicate determinations).

* The work was carried out with the participation of A. S. Zhavoronkina and I. I. Kargin.

As follows from the data presented, the crystals are sufficiently homogeneous in composition, although there is a slight tendency toward an increase in the hausmannite content in the direction toward the bases of the crystals. The difference in the content of Mn_3O_4 is very small and lies within the error of the analysis; the only exception is the very upper parts of the crystals. This can apparently be explained by the fact that, up to the moment when growth ceases, the crystal tips are located in that part of the flame where the $H_2 : O_2$ ratio is shifted toward an increased hydrogen content.

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