

Synthesis and structure of TmFe_2O_4

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Abstract

This research reports about synthesis of TmFe_2O_4 at low partial oxygen pressure. The substance belongs to the class of materials based on transition metal oxides where the metals have mixed valence. Such materials are related to multiferroics, a class of substances with combined ferromagnetic and ferrielectric properties. An upgraded method of synthesis, where a gaseous mix of argon or nitrogen with oxygen is used, and partial oxygen pressure is controlled by a regulator with an oxygen pump, has been applied to synthesize thulium ferrite. For the first time, the ferrite has been obtained at the temperature lower than 1200 °C, namely 1090 °C. A stability range of the ferrite related to the partial oxygen pressure has been defined and equals to $10^{-16.2}$ – 10^{-18} atm. Structural parameters of TmFe_2O_4 are analyzed by X-ray diffraction. The sample has rhombohedral structure ($R\bar{3}m$ space group). A change of unit cell parameters, structure, bond lengths has been studied in the temperature range from -140 to 140°C. The space group remains the same within the studied range of temperature. The parameter a continuously increases in the whole range studied which is caused by thermal expansion. Also, a negative thermal expansion coefficient is observed along the c -axis in the temperature range from -20 to 140 °C. This phenomenon is explained by the deformation of structural fragments – the contraction of TmO_6 octahedrons along the axis z .

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