Terbium phosphates crystallization from potassium tungstate molten salts

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Abstract
A set of terbium-containing phosphates has been prepared by spontaneous crystallization from potassium tungstate melts. To avoid redox reaction in the molten media the application of terbium(III) fluoride has been proposed. Crystallization regions of $TbPO_4$, $K_3Tb(PO_4)_2$ and $K_2Tb(PO_4)(WO_4)$ has been identified by X-Ray powder diffraction. The peculiarities of $K_3Tb(PO_4)_2$ crystal structure have been studied in detail.

Key words: phosphor, terbium, solid solution, phosphate, molten salt, tungstate

I. Introduction

The development of new materials based of rigid oxide frameworks with tailored physical and chemical properties is one of the important areas of modern materials science, which lies at the intersection of physical and inorganic chemistry. In this aspect, much attention has been paid to the synthesis of functional materials based on phosphates of alkaline and trivalent elements (Zhu, 2020). Taking into account the principles of "green" energy and energy saving requirements, framework phosphates have become especially important due to the high quantum luminescence yield, low cost, low toxicity, and high resistance to temperature and humidity changes (Sun, 2019).
The aim of the titled thesis is to optimize terbium phosphates crystals in a wide range of molten salts ratios and to elucidate the effect of the reaction media on crystallization trends.

II. Experimental

To prepare single crystals of terbium phosphates the molten system K – Tb – W – P – O has been briefly studied. The composition of molten salts corresponds to a KPO_3-$K_2W_2O_7$ mixture with molar ratio 8:2:1, where $K_2W_2O_7$ plays the role of the flux. Experiments were carried out using analytically pure K_2CO_3, WO_3, TbF_3 and KPO_3. Calculated amount of the reagents were preheated at 700°C and were held at 900 °C during 2-3 hours in a platinum crucible. A homogeneous high-temperature solution obtained in this way was gradually cooled with a rate of 100°C /h to 500°C and, finally, poured out on a copper sheet. Crystalline products were retrieved from a solidified melt in hot distilled water.

III. Analysis

The process of formation of orthophosphate was monitored by IR spectroscopy and X- Ray powder diffraction

IV. Results and discussions

Depending on K/W ratio the regions of $TbPO_4$ with three-dimensional structure has been identified in case of $K_2W_2O_7$ molten media. The crystallization of layered $K_3Tb(PO_4)_2$ and $K_2Tb(PO_4)(WO_4)$ has been found in case of K_2WO_4- containing melts. The crystal structure of double potassium –terbium phosphate is shown to be arcanite-related.

V. Conclusions

The effects of K/W ratio on the crystal structure, morphology, band gap value and were investigated by X-ray powder diffraction and IR spectroscopy. The crystal structure change has been studied in detail for a single crystal $K_3Tb(PO_4)_2$ grown from a melt.

References

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