

NOTE

Luminescence of Aluminum Vanadate (AlVO_4)

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Aluminum vanadate (AlVO_4) shows a broad-band emission peaking at 620 nm at temperatures below 100°K. The luminescence is discussed in connection with the crystal structure.

Introduction

Many simple vanadates, niobates and tungstates show efficient luminescence at room temperature. Examples are $\text{Zn}_3(\text{VO}_4)_2$ (1), YNbO_4 (2) and CaWO_4 (3). In view of this we have investigated the luminescence properties of the relevant aluminum compounds. These have complicated crystal structures which seem to complicate the luminescence properties too. Those of AlNbO_4 have been reported recently (4). Those of AlVO_4 are reported in this note: those of $\text{Al}_2(\text{WO}_4)_3$ will be published in due time.

The crystal structure of AlVO_4 have been given by Baran and Botto (5) and is isomorphous with that of FeVO_4 (6). Doubly-bent chains of edge-sharing aluminate polyhedra (AlO_6 and AlO_5) are joined by VO_4 tetrahedra. There are three crystallographically different sites for vanadium.

Experimental

Samples were prepared as described in the literature (5). They were checked by X-ray analysis and infrared spectroscopy (5).

Optical measurements were performed as described before (4).

Results

Samples of AlVO_4 were brownish. After treatment with a sodium hydroxide solution to remove unreacted V_2O_5 they became light grey. We did not succeed in the preparation of white AlVO_4 . The colour is ascribed to an oxygen deficiency in spite of an oxygen firing atmosphere. The diffuse reflection spectrum shows an optical absorption edge at about 360 nm with a tail into the visible. The samples showed a strong orange emission under ultraviolet excitation below about 100°K. The excitation spectrum starts at about 360 nm and reaches at about 330 nm a flat broad maximum extending over nearly 100 nm. The emission spectrum did not depend on excitation wavelength. It consists of a broad band peaking at about 620 nm.

Discussion

The spectral characteristics of AlVO_4 are not strikingly different from those of

$Zn_3(VO_4)_2$ and $Mg_3(VO_4)_2$ (1). The thermal quenching temperature of the luminescence of $AlVO_4$, however, is much lower, viz. 100°K instead of some 400°K. In view of the large Stokes shift of the emission (some $14\,000\text{ cm}^{-1}$) effective energy migration through the host lattice seems rather improbable (7). It was shown that the stiffness of the host lattice determines the value of the quenching temperature (1). At first sight the Al^{3+} ions seem to provide a stiff surroundings around the vanadate groups (8). The open chain structure of $AlVO_4$, however, is not stiff at all. This is illustrated clearly by the fact that the high-pressure transformation of isomorphous $FeVO_4$ to the wolframite structure results in a volume decrease of about 30% (6). The low quenching temperature of the luminescence of

$AlVO_4$ is, therefore, not surprising. At the same time a possible high-pressure modification of $AlVO_4$ is expected to be an efficient luminescent material.

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