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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 $Zn_3(VO_4)_2$ (*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 $Al_2(WO_4)_3$ 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

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$Zn_3(VO_4)_2$ 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 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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