

YAlO₃ WITH TR³⁺ ION IMPURITY AS AN ACTIVE LASER MEDIUM

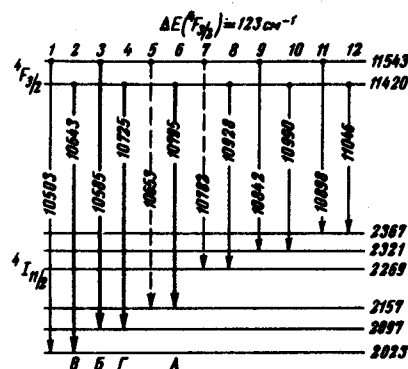
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We obtained the conditions and synthesized single crystals of YAlO₃ with perovskite structure, namely the second stable compound (1:1) in the Y₂O₃-Al₂O₃ oxide system, the main phase of which (3:5) is the Y₃Al₅O₁₂ crystal. Comparison of the two compounds shows that YAlO₃ is a more convenient matrix for activation with rare-earth ions (TR³⁺) since their distribution coefficients during growth are close to unity. The low symmetry (D_{2h}¹⁶ - Pbnm) and the closer packing of YAlO₃ predetermines the formation of a more convenient structure for their activator centers (TR³⁺) from the point of view of lifting the hindrance to electronic transitions. The results of a comprehensive set of spectroscopic investigations of YAlO₃:TR³⁺ crystals, including a study of stimulated transitions, have confirmed these general considerations. By way of an example, we present below some basic spectroscopic and lasing characteristics of YAlO₃:Nd³⁺ crystals (~3 wt.%). A laser based on these crystals emits at 300°K and at a threshold $E_{thr} \sim 1.5$ J at a wavelength 10795 Å (line A). In the continuous regime, $E_{thr} \sim 1.8$ kW (crystal rod length ~30 mm and diameter ~3.5 mm). The cross section σ_e of the stimulated transition A is estimated at $(1.2 \pm 2) \times 10^{-18}$ cm², which is 1.1 - 1.3 times larger than σ_e of the fundamental transition (10641 Å) of the Y₃Al₅O₁₂:Nd³⁺ crystal, which presently is the main active medium for CW crystal lasers. The lifetime of the metastable state is 65 ± 10 μsec, and the splitting of the ⁴F_{3/2} term is 123 cm⁻¹ at 300°K and 129 cm⁻¹ at 77°K. In a laser with a combined active medium YAlO₃:Nd³⁺ + SrF₂-LaF₃:Nd³⁺ at 300°K, three additional stimulated transitions were registered and investigated. The figure shows the scheme of the Stark levels of the ⁴F_{3/2} and ⁴I_{11/2} terms and their connection with the observed stimulated transitions. The experimental technique and the investigation methods are similar to those used in [1,2].



Stark-level scheme of the ⁴F_{3/2} and ⁴I_{11/2} terms of Nd³⁺ ions in YAlO₃ crystals at 300°K. The level positions are indicated in cm⁻¹, and those of the transitions between them in Å. The heavy arrows denote the observed stimulated transitions.

- [1] A. A. Kaminskii, Zh. Eksp. Teor. Fiz. 51, 49 (1966) [Sov. Phys.-JETP 24, 33 (1967)].
- [2] A. A. Kaminskii, G. A. Bogomolova, and L. Li, Zh. inorg materialy (Inorganic Materials) 2, 673 (1969).