Saturation of the Nuclear Magnetic Resonance in the Ferromagnetic Domain Boundary

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(Summary)

The dynamic magnetic susceptibility of the electron-nuclear system in the domain boundary (DB) has been studied theoretically taking into account the nonlinearity that appears because of the saturation of the nuclear magnetic resonance (NMR). The spectrum of the system's oscillations in the NMR frequency region is shown to depend substantially on the excitation field strength and may be with parameters that are close to those of the NMR spectrum in DB or in the domain. A change in the spectrum is observed also with increasing parameter of electron-nuclear interaction: the field strength required to saturate the NMR in DB also increases.

On the Emission of Gallium Activated Single Crystals of Barium Chloride

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We have given the results of $BaCl_2$-Ca emission for the first time. The emission has been studied at 78 K and 300 K, and the results obtained show the main formation of one kind of centres with maximum of the emission at 397 nm, at 300 K. By the formation of another kind of more complex in composition and structure monovalent gallium centres the complex spectral distribution of the emission band at 78 K may be explained.

1. Introduction

Gallium-activated alkali halide crystal phosphors (ns^2-activator) are well known so far. The interest in them is determined by the intensive luminescence which is at the root of many technical applications. Detailed investigations are done not only of the absorption and emission spectra, but also of FPR spectra, MCD spectra, of the polarization of the emission and its temperature dependence in order the structure of the emitting centres to be made more precise [1—4].

Recently studies of alkaline earth chloride and bromide crystals activated by ns^2-activators have begun. Data about Sn, Pb and In as activators of $SrCl_2$, $BaCl_2$, $BaBr_2$ are known so far [5—11]. The paper presents the first results of the emission of gallium activated single crystals of barium chloride.

2. Experimental procedure

Single crystals of barium chloride have been prepared in evacuated quartz tubes using a horizontal variant of the Bridgman method. $BaCl_2$ (Suprapur Merck) was first dried in vacuum at 120°C and after that at 350°C in flow of dried HCL for 5 hours. Plates of dimensions $5\times5\times3$ mm were cleaved from the crystals. The activation of the single crystals was achieved by heating the plates in high vacuum at 700°C in the presence of metal gallium (high purity). After about 2 hours an appearance of intensive luminescence is being observed. The method of measuring the emission and excitation spectra has been described in our previous work [8]. Prior to measurement the crystal plates were quenched.

3. Experimental results

Figure 1 represents emission spectrum of the phosphor studied at 78 K and 300 K. The spectrum at 300 K consists of an intensive band with a maximum at 397 nm (halfwidth 55 nm). The lowering of the temperature to 78 K leads to decreasing the intensity and moving the band in the longwave direction. The complex spectral distribution of the emission intensity at 78 K gives the existense of more than one overlapping bands in the longwave region to be assumed.

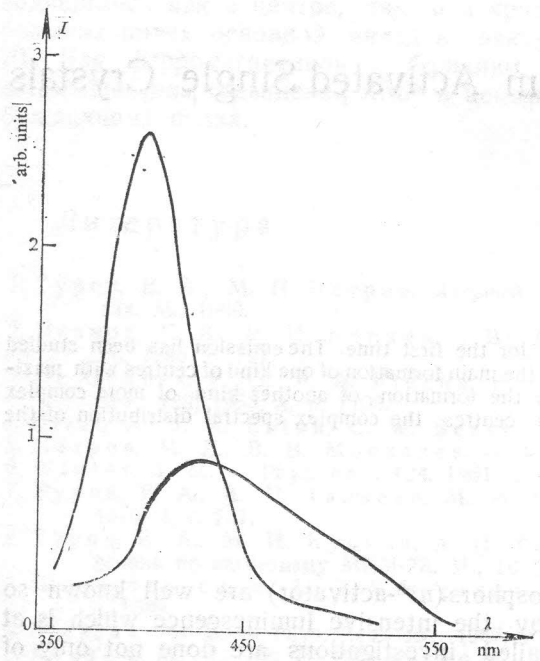

Fig. 1. Emission spectra of $BaCl_2$-Ga at: *1*—78 K; *2*—300 K

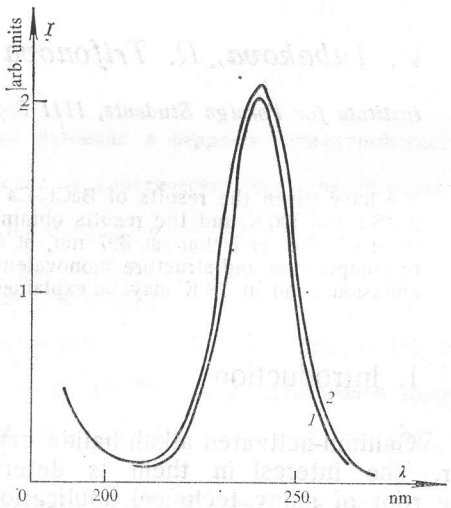

Fig. 2. Excitation spectra of $BaCl_2$-Ga at: *1*—78 K; *2*—300 K

The excitation spectrum at 300 K and 78 K (Fig. 2) has a maximum at 240 nm. In the shortwave region of the spectrum an asymmetry has been observed which gives reason to be suggested that there are other bands in the region under 200 nm.

4. Discussion

The assumed mechanism to form emitting centres in $BaCl_2$-Ga is the following: being in a gas phase a metal activator by the contact with the surface of the $BaCl_2$ crystal turns mainly to Ga^+. (The Ga^{3+} formed at the same time with them at the presence of metal gallium at high temperature of activation turns to Ga^+, too.) The small ionic radius of Ga^+ and the high temperature suppose easy diffusion of gallium ions in the $BaCl_2$ crystal. Ga^+ and Ba^{2+} ions are not isovalent, that is why incorporating of Ga^+ in the place of Ba^{2+} in the crystal lattice requires a formation of charge compensating anionic vacancies.

So the centres formed may differ in composition and structure. It is known that by quenching the number of one kind of the centres is increasing considerably.

The observed relatively symmetrical and with small half-width intensive emission band (at 300 K) is connected with the presence of a big number of equal composition and structure centres. The asymmetry in the longwave region of this band and also the complex spectral distribution of the emission intensity at 78 K give reason for the existence of more than one overlapping bands to be assumed. Perhaps these bands are connected with another kind of emitting Ga^+ centrés with a symmetry different from that of the above mentioned centres. Nevertheless, one should have in mind the possibility of existing of microregions with cubic symmetry in the $BaCl_2$ rhombic crystal lattice.

The data obtained so far do not afford an opportunity the symmetry of the emitting centres to be determined. On the analogy of the alkali halide phosphors the $BaCl_2$-Ga emission may be connected with transition from one kind of minimum on the APES of $^3T_{1u}$ to the ground state $^1A_{1g}$ in Ga^+ centres with different symmetry.

The low symmetry of gallium centres in $BaCl_2$ supposes a presence of several bands in the absorption spectrum and in the excitation spectrum, respectively. Our experimental data concerning the excitation spectrum do not show structure even at 78 K. An explanation of the obtained results can be offered by accepting that the only band in the excitation spectrum corresponds to the transition $^1A_{1g} \rightarrow {}^3T_{1u}$. As the absorption edge of $BaCl_2$ is far in the UV vacuum, the rise of the intensity at 180—200 nm is a good reason to assume that below 200 nm there exist other absorption bands, as well as their corresponding bands in the excitation spectrum.

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Об излучении монокристаллов $BaCl_2$-Ga

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(Резюме)

Впервые исследованы спектры излучения и возбуждения кристаллофосфора $BaCl_2$-Ga при температурах 78 K и 300 K. В эмиссии при 300 K обнаружена относительно симметричная полоса с максимумом при 397 nm. При понижении температуры до 78 K интенсивность излучения понижается, и полоса перемещается в сторону длинных волн. В спектрах возбуждения при 300 K и 78 K обнаружена только одна полоса при 249 nm. При обсуждении полученных результатов принимается формирование одного типа галиевых центров.

Absorption and Luminescence Properties of Nd^{3+} Activated Optical Fibers

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The absorption and luminescence properties of Nd^{3+} activated optical fibers have been studied in the 400—1200 nm spectral range. The activator's maximum resonance absorption bands and the absolute values of the spectral attenuation coefficients have been found. Under resonance excitation by the second harmonic of the Nd^{3+} : YAG laser, luminescence spectra have been recorded in regions centred around 900 nm and 1060 nm. The lifetime of the upper laser level has been evaluated.

1. Introduction

The optical fibers of multi-component and quartz glasses activated with rare earth elements (Nd^{3+}, Er^{3+} etc.) have been used to develop optical fiber laser and amplification systems [1—9] of sensitive sensor and functional devices [10]. The active optical fibers (AOF) combine the useful properties of the solid state amorphous laser materials with the advantages offered by the fiber light guides such as the attenuation of high emission density at a relatively low generation threshold and long distance of interaction, possibilities to generate in continuous and pulse (Q-modulation [1—3] or mode-locked [4—5]) regime, amplification of superweak optical signals and effective compatibility with conventional optical fibers.

In the design and study of AOF systems and devices, the spectral characteristics of AOF have a definite importance for the preliminary choice of active fibers and specific setups for their excitation. The methods and experimental setups for the analysis of these characteristics are based on the study of the absorption and luminescence properties of AOF [11—13].