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Luminescence of Cr^{3+} complexes in Al_2O_3

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Luminescence of ruby with high chromium concentration (up to 2.3 mass.%) has been investigated. Measurements include concentration dependences of the *R* and *N* lines positions and intensities. A statistical model has been developed describing the relative intensities of the *N* line as compared to that of the *R* one. The hydrostatic pressure (up to 80 kbar) effect on fluorescence spectra of the *R* and *N* lines has been studied, too.

Исследована люминесценция рубина с высокой концентрацией хрома (до 2,3 % мас.). Измерения включали определение концентрационных зависимостей положений и интенсивностей линий *R* и *N*. Разработана статистическая модель, описывающая относительную интенсивность линии *N* по сравнению с интенсивностью линии *R*. Исследовано также влияние гидростатического давления (до 80 кбар) на спектры флуоресценции линий *R* и *N*.

The diamond anvil cell (DAC) has revolutionized the high-pressure experimentation. Diamond anvils are used to generate very high pressures because diamond is the hardest substance known, and transparent to photons over a wide energy range. High pressure changes constants of crystal lattice without changing the composition of solid. This can produce large changes in electronic energies [1].

Several workers have studied the fluorescence and absorption lines of heavily doped ruby [2–7]. Tolstoy and Fu [2] observed that the intensity of emission band at about 770 nm increases with chromium concentration and connected this fact with the formation of Cr^{3+} clusters. Since that time, several authors [3–7] have assigned lines in the region of that band to transitions of Cr^{3+} pairs.

There are several important motivations for studying heavily doped ruby. One is the need to understand the concentration-dependent loss mechanisms in fluorescent materials. Heavily doped ruby is a good material for studying the basic physics of the interaction of impurity ions in a crystalline host. In this paper we present new results on spectroscopy of heavily doped ruby (Al_2O_3 doped Cr^{3+}).

We have investigated the luminescence of ruby crystals with chromium concentration equal to 0.1 mass.%, 0.9 mass.%, 1.2 mass.%, 1.9 mass.%, 2.3 mass.%. High pressure was generated in diamond anvil cell using 4:1 methanol-ethanol mixture as the pressure transmitting medium. Our spectral data have been collected with optical multichannel analyzer. Excitation was provided by the 488 nm line of Ar laser. All experiments have been performed at room temperature.

At low chromium concentration (0.1 mass.%), the Cr^{3+} luminescence is dominated by the two strong lines (R_1 and R_2) [2, 4] of the isolated single Cr^{3+} ions. At