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LUMINESCENCE OF INTRINSIC DEFECTS IN POLYCRYSTALLINE ZnO

N.L ALUKER

Kemerovo State University, Kemerovo, Russia,
Russia Federal Research Center of Coal and Coal Chemistry, SB RAS ,Kemerovo, Russia

The luminescence of undoped ZnO powders at room temperature has been studied. Photoluminescence was studied upon excitation by microsecond pulses from the region of interband transitions and the region of exciton absorption in the reflection scheme.

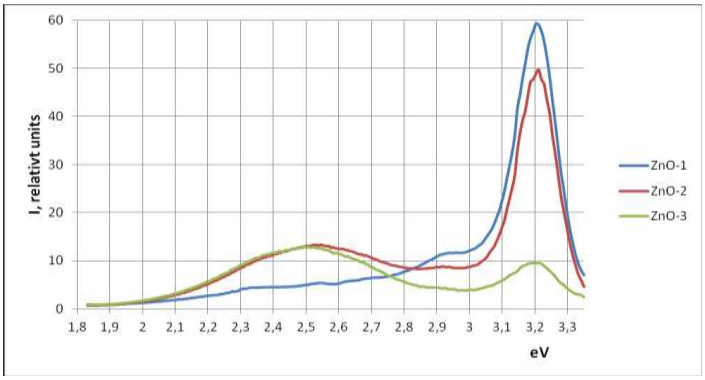

Fig.1. Luminescence of Samples with Different Contents of Growth F Centers.

The luminescence spectra exhibit two regions characteristic of ZnO: a short-wavelength region (~3.2 eV), associated in the literature with exciton luminescence, and a long-wavelength region, due to the presence of growth structural and impurity defects [1–3]. The observed long-wavelength luminescence is divided into components with different luminescence durations, and several components that form broad long-wavelength luminescence are identified. It is formed by at least three stripes. Fast luminescence (≤1 μs ~2.52 eV), long luminescence (≤500 μs ~2.69 eV). The longer wavelength component ≤2.32 eV, which is less reproducible for different samples, falls over times ≤100 μs. The yields of "exciton" luminescence and long-wavelength luminescence depend differently on the intensity of the exciting light. At very low intensities, only high-yield UV luminescence is observed, which decreases with increasing light pulse intensity. At medium intensities, there is a segment of the decrease in UV luminescence along with an increase in long-wavelength luminescence (competing processes). Subsequently, a slight increase in the luminescence yield is observed in both bands.

A comparison of the experimentally observed luminescence with calculations of the energy of the main defects led us to the conclusion that, for a consistent explanation of luminescence in undoped zinc oxide at room temperature, it is sufficient to consider the participation of only anionic sublattice defects in the process. In this case, it is necessary to assume the possibility of the coexistence of free and self-trapped excitons in ZnO. For self-trapping of a free exciton, there must be a small barrier that can be overcome at kT and limits self-trapping at low temperatures. The UV band (~3.2 eV) and the band at 2.52 eV are associated with the radiative decay of excitons in a regular lattice or at shallow traps (for example, F++ centers). The broad, long duration luminescence ~2.69 eV is determined by the triplet transition of the excited F center.

Luminescence associated with growth defects of the cationic sublattice is likely to manifest itself in powders with an excess of Zn in the region of 2.95 eV.

To implement the transitions associated with the charge exchange of the F-center, it is necessary to assume that the excited singlet state (F)* is in the conduction band, and the triplet state has a level in the band gap.

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