Building-Up of X-Ray Luminescence and Conductivity in ZnSe Crystals

M. Alizadeh[1], V.Ya. Degoda[1], N.Yu. Pavlova[2]

[1]*Taras Shevchenko National University of Kyiv, 64 Volodymyrs'ka Str., 01601 Kyiv, Ukraine*
[2]*National Pedagogical Dragomanov University, 9 Pyrogova Str., 01601 Kyiv, Ukraine*

In high-resistivity ZnSe crystals ($\rho \geq 10^{12}$ ohm•cm), at X-ray excitation luminescence (XRL) intensity observed two luminescence bands with maxima at 630 and 970 nm, and easily recorded the X-ray conductivity (XRC). Experimentally investigated the kinetics of luminescence and conductivity when the continuous X-ray irradiation (0,635 mW/cm^2) at temperatures of 8, 85, 295 and 420 K. The kinetics of luminescence and conductivity in crystal greatly depends not only on the concentration of different luminescence centers, but also on the concentrations of different traps.When the luminescence kinetics studies and conductivity can use the fact that at different temperatures have different relationships between the shallow and deep traps. And it should change the nature of the curves the luminescence and conductivity. An important feature of the measurements is the simultaneous recording of both the intensity of the luminescence emission bands and the amount of conduction current.

Experimentally found that the curves of XRL intensity bands 630 and 970 nm between a curve and the current of XRC building-up differ markedly at low temperatures (when the concentration of deep traps more for the concentration of small traps). But the most interesting feature of the kinetics observed for the building-up conductivity at low temperature (8 K) – be 2 seconds late by almost from the moment when the X-ray excitation starting. Also at low temperatures (8 and 85 K) observed a significantly lower the rate of building-up of current in comparison with the rate of the luminescence.

An explanation of the observed features in the XRL and XRC at different temperatures in these crystals of ZnSe. If you remember that the area of generation of free electron-hole pairs at each photo absorption of X-ray quant (Ø ~ 100-300 nm) is much smaller than the dimensions of the sample, and their concentration in this area of excitations are comparable to concentrations of luminescence centers and traps, the bulk recombination occurs in this area, which create a scintillation flash. Naturally, these recombine at the luminescence centers, free electrons and holes do not participate in current conduction. Thus, the more efficient the crystal as a scintillator, the lower portion of the ionizing radiation-generated free carriers participating in conduction current. In addition, to participate in the conduction current of free charge carriers have markedly spatially displaced from the area of generation due to the drift-diffusion motion, i.e. have a sufficiently long lifetime in the zone. At the helium temperatures, when all the traps in the crystal are deep, and the lifetime of free carriers increases as the traps filling rate. And, accordingly, current conduction occurs only after partial traps filling rate and speed with increasing radiation dose reflects the rate of filling the traps. For luminescence kinetics have an instant increase in intensity due to scintillation, and further a relatively small increase in the expense of increasing the concentration of luminescence centers reloaded during the X-ray crystal phosphor excitation.