Appearance of Electret Effect in The Cathodoluminescence of Intercalated GaSe

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Intercalation by foreign atoms (guests) of different nature allows to modify significantly the physical properties of the semiconducting compounds and to use them as sensitive materials of microelectronics. Layered GaSe crystals intercalated by $NaNO_3$ or oligomer possessing the different dipole moments, can be successfully used in optoelectronics, particularly in the structures with high dielectric screening.

In this contribution we show the experimental results for cathodoluminescence (CL) spectra of GaSe crystals intercalated by $NaNO_3$ and oligomer, received at low temperatures. The CL spectra were measured at 80K with a set-up based on a DMR-4A monochromator and a PMT FEU-106 under pulsed e-beam excitations (duration of pulse of 2μs at frequency of 30-3 Hz) with an energy of electrons of 9keV and a beam current of 100 μA. The CL spectrum of GaSe intercalated by $NaNO_3$ (oligomer) presents the luminescence shifted with respect to the pure GaSe on 0.1eV (0.08eV) and with half-width 0.08eV(0.1eV).

Appearance of additional maxima shifted by 0.1eV for GaSe<$NaNO_3$> and 0.08eV for GaSe<oligomer> we explained within the framework of the model of virtual guest-crystal with additional band of guest states [1]. Density of electron states of pure layer crystal and guest virtual crystal is described by Fivaz dispersion law. We considered: i) the anisotropy of electron host-guest overlapping; ii) nonmonotonic change of lattice constant along the main crystallographic axis C depending on guest concentration. In the case when electret effect appears we consider positioning of the intercalant (guest) in two different potential wells T_1 and T_2 of different depth in he unit cell; the concentrations p_1 and p_2 are different. Our calculations showe that if $p_1=0.98$ and p_2 changes from 0.2 to 0.7 the width of additional gap that appears due to the itercalation changes in a monotonic way. The shift of the additional gap depends strongly on the value of the intercalant ground state energy ($\varepsilon_1=\varepsilon_2$) and on its position (below or above the bottom of the conduction band). It is shown that in the case of ordered electret like distribution of intercalant in the van der Waals gaps the shift of peaks of electron density of states can be explained by Keldysh-Frantz effect.

1. Tovstyuk N.K. Band structure of GaSe with guest components of different nature. Visnyk of Ivan Franko LNU. Physics Series - 2013.- v.48 . - P.109-119.