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Peculiarities of power- and temperature-dependent photoluminescence of MBE grown GaAsBi layer.

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Bismuth (Bi) incorporation in GaAs induces band-gap reduction, increase in spin-orbit splitting energy, changes in effective mass, and all of this makes GaAsBi an attractive material in optoelectronics for applications in the near-infrared and terahertz range [1]. Both nondestructive methods, such as power-dependent and temperature-dependent photoluminescence (PL), give valuable information. Analysis of thermal quenching of the PL signal by fitting it with the expression of the Arrhenius type shows activation energies E_{ai} of processes in the material [2]:

$$I_{\mathrm{PL}}(T) = \frac{I_{\mathrm{PL}}(0)}{1+C_1\exp(-E_{\mathrm{a1}}/kT)+C_2\exp(-E_{\mathrm{a2}}/kT)} \dots \quad (1)$$

Here, C_i are the fitting parameters; k is a Boltzmann constant.

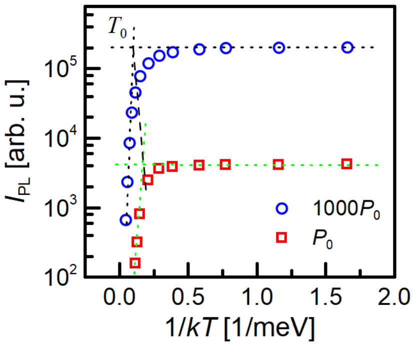

Fig. 1 Arrhenius plots of the temperature-dependent PL intensity from GaAsBi layer at two excitation intensities. Lines are as guidelines.

However, the drop in PL intensity near critical temperature T_0 (see Fig. 1, point where the largest slope crosses the extrapolated low-temperature part) may be very abrupt (nearly vertical in the Arrhenius plot), so that the 'activation energy' or the measured slope could have no physical meaning. Nevertheless, the ionization energy E_a of the acceptor can be found from the fit of the T_0 dependence on the G generation rate (or excitation intensity P) using Equation (2) [3]:

$$T_0 = \frac{E_{\mathrm{a}}}{k\ln(B/G)} \dots \quad (2)$$

Here, B is a constant for the acceptor. The parameter C_i in (1) can formally be changed as $C_i = B_i/G$.

We will discuss about the energy values extracted using Equations (1) and (2), check their correlation with the values of the mobility edge extracted from time resolved PL measurements and the energy scale of disorder extracted from the temperature-dependent PL peak energy.

REFERENCES

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