# Reply to ''Comments on 'Line shape, line width, and configuration coordinate diagram of the Cu band (1.21 eV) in InP' '' [J. Appl. Phys. 80, 1937 (1996)]

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We have used Gaussian shape of individual phonon replicas for fitting the experimental curve as suggested by Collan and Krustok. Better fit has been obtained using the parameters $E_0$ (zero phonon energy)=1.28 eV, $E_{ph}$ (phonon energy)=0.038 eV, $\delta$ (phonon broadening parameter)=0.026 eV and $S$ (Hwang–Rhys factor)=2.13. Thus, the results of Pal and Bose remain unchanged. Fitting parameters used by Collan and Krustok have no physical significance. © *1996 American Institute of Physics.* [S0021-9606(96)02315-X]

The Lorenzian line shapes assumed in our article follow the work of Temkin *et al.*[1] on deep radiative levels in InP who, on the basis of their analysis, found $E_{ph}$=0.038 eV. It is observed that the Gaussian shape of individual phonon replicas fits our experimental curve better, as pointed out by Collan and Krustok. We have fitted this curve using Eq. (2) given by Collan and Krustok and have found better fit using the parameters $E_0$ (zero phonon energy)=1.28 eV, $E_{ph}$ (phonon energy)=0.038 eV, $\delta$ (phonon broadening parameter) =0.026 eV and $S$ (Hwang–Rhys factor)=2.13 as shown in Fig. 1(a). Collan and Krustok have found best fit using the parameters $E_0$=1.224 eV, $E_{ph}$=0.075 eV, $\delta$=0.045 eV, and $S$=0.27. We have used Collan and Krustok's parameters for fitting the experimental curve using Eq. (2) which is also shown in Fig. 1(b). It is seen that the low-energy side of the curve does not fit as well as reported by Collan and Krustok.

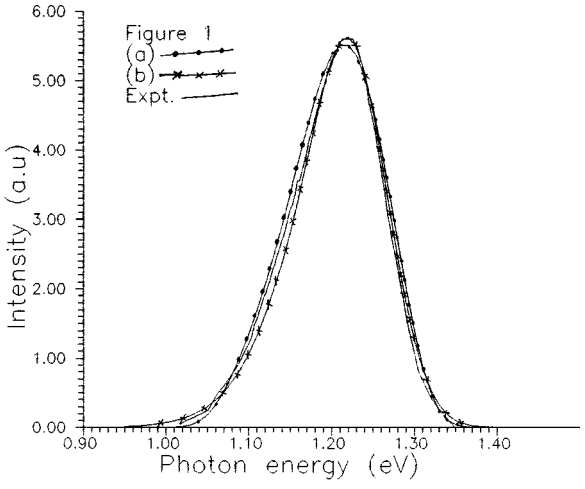


FIG. 1. Photoluminescence spectrum of the Cu-diffused InP at 10 K. Theoretical spectra using the parameters (a) $E_0$=1.28 eV, $E_{ph}$=0.038 eV, $\delta$=0.026 eV and $S$=2.13, and (b) $E_0$=1.224 eV, $E_{ph}$=0.075 eV, $\delta$=0.045 eV and $S$=0.27 eV.

Furthermore, the above parameters used by Collan and Krustok are arbitrary and do not have physical significance. According to Temkin *et al.*[1] the zero phonon energy is the sum of the band peak energy and thermal activation energy for photoluminescence quenching. In the present case this is found to be 1.216+0.077=1.293 eV. Thus, we have taken zero phonon energy~1.29 eV whereas Collan and Krustok have used 1.253 eV for improved Lorenzian and 1.224 for best Gaussian.

For the coupled phonon energy associated with the transition it has been considered that an electron trapped at the radiative center interacts with both optical and acoustic phonons.[2] Yu[3] stated that the TO phonon energy with $E_{ph}$=0.038 eV at the $\Gamma$ point is involved; however, this is not correct.

Banerjee, Srivastava, and Arora,[4] in studying deep centers in InP have used a Gaussian distribution and found phonon energies varying from 0.039 to 0.043 eV with $S$=1.2–2.0. It is thus questionable whether the value of 0.028 eV for best Lorenzian or 0.075 eV for best Gaussian fits assumed by Collan and Krustok are reasonable.

We do not have access to their unpublished work (their Refs. 3 and 7) and, hence, are unable to comment further, although we are aware of the shortcomings of the CC model. Due to differences in ionicity and defect energies their results on CdS and CdTe may not be directly translatable to the present case.

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