Journal of Luminescence 40&41 (1988) 527–528
North-Holland, Amsterdam

OPTICAL NONLINEARITY DUE TO INCREASED ABSORPTION IN CdS AT ROOM TEMPERATURE

Fang YANG, Duolu LI, Nailiang TIAN, Guangnan XIONG and Xurong XU

Changchun Institute of Physics, Acadmia Sinica, Changchun, China

Two types of the increased absorption with increasing excitation intensity at room temperature were observed. The experimental results show the origin of the nonlinearity.

1. INTRODUCTION

In this paper two types of optical nonlinearity in CdS crystal platelets due to the increased absorption with increasing incident intensity at room temperature (RT) are reported. The experiments reveal their origin. One is ascribed to the effect of lattice heating in the transmission of a laser tuned around the exciton in CdS. The other is ascribed to the absorption band of exciton-electron (Ex-El) scattering moving towards the low energy direction under high excitation.

2. EXPERIMENTAL

The investigated samples are undoped single crystal platelets of CdS with the axis in the plane of the platelets and thickness from 10 to 100 micrometer. The 514.5nm single line of a mode-locked Ar^+ laser (with pulse duration 180ps, repetition rate 82MHz) is used to study the transmission property of the samples around RT. The excitation intensity is up to 110kW/-cm^2. The laser beam passes through a variable speed chopper and illuminates on the samples and then is detected by a powermeter. With the chopper, the exposure time (ET) of the samples can be controlled from several hundred microseconds to a rather long time by changing the speed of the chopper. Then a wide-band dye laser (Coumarin 485) pumped by a N_2 laser (with pulse width 8ns and repetition rate 10Hz) is used to investigate the transmission vs. the input intensity at different photon energies. Here the excitation intensity is up to several MW/cm^2.

3. THE RESULTS AND DISCUSSION

As the Ar^+ laser continually illuminated on the samples, linear transmission were found when the input intensity I_0 was lower than 7mW. As I_0 was greater than 7mW, a significant increasing absorption occured, the relation between input and output light shown in Fig. 1. Decreasing ET of the sample, the transmission increased continually until ET was lower than 0.4ms. Further decreasing ET, the transmission did not depend on ET. This means the nonlinearity was due to thermal effect as ET was longer than 0.4ms.

The new finding is, when ET was smaller than

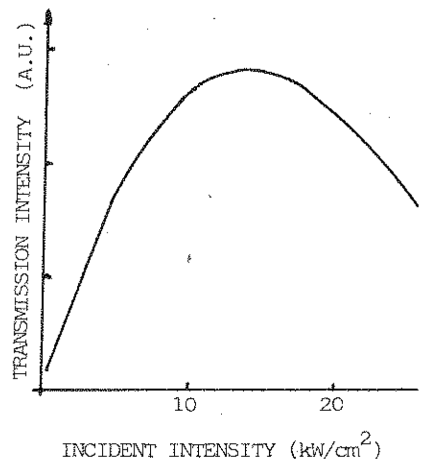

FIGURE 1
Transmission intensity as a function of incident intensity, the laser wavelength 514.5nm, temperature 290K.

0022-2313/88/$03.50 © Elsevier Science Publishers B.V.
(North-Holland Physics Publishing Division)

0.4ms, we also observed an increased absorption with increasing input intensity. Here thermal effect could be neglected for the nonlinearity was rather weak and the average input power was smaller than 1mW, this value is one order smaller than that in Ref. 1. To make it certain, we measured the temperature dependence of 514.5-nm laser as the absorption edge shifts with the temperature increasing. As shown in Fig. 2, when the temperature was low enough to make the laser far from the resonant position of the exciton level, the transmission was linear. At the temperature where 514.5nm laser was just about equal to exciton level, an obvious nonlinearity was found. Further, the investigation of the photon energy dependence of transmission was done by using a tunable dye laser. The results show in Fig. 3, as the photon energies were below and around 2.3714eV, no nonlinearity was found. As the photon energies were between 2.3965 and 2.4094ev, nonlinearity was clearly observed, where the photn energies were

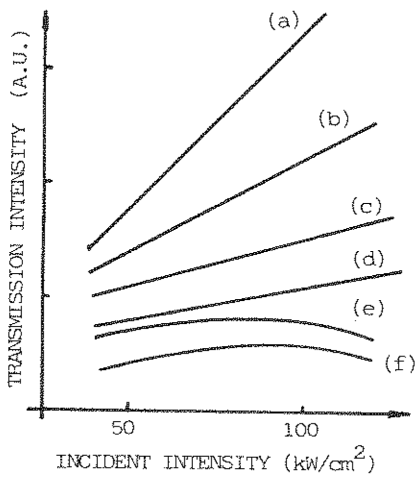

FIGURE 2
Transmission as a function of incident light at different temperature. Laser wavelength 514.5nm, the temperatures of sample are (a) 5°C, (b) 10°C, (c) 15°C, (d) 20°C, (e) 27°C, (f) 32°C.

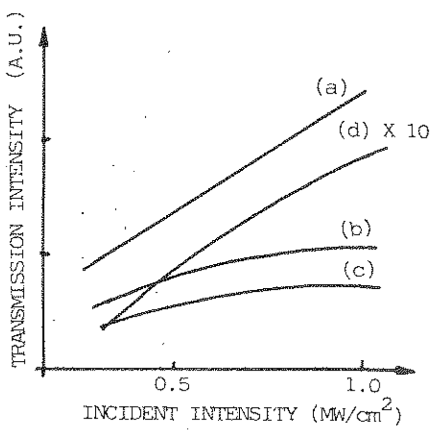

FIGURE 3
Transmission as a function of incident intensity with different photo energies (a) 2.3714, (b) 2.3965, (c) 2.4094, (d) 2.4353 (eV). Temperature of saple 286K, exciton level 2.4219 eV.

slightly below the exciton level 2.4219eV. Compared with luminescence spectra in Ref. 2, the photon energy of input laser is just below the peak of Ex-El scattering process where the nonlinearity occured. Calculation confirms that the absorption band of Ex-El scattering has a red shift with increasing excitation. These suggest the nonlinearity come from Ex-El scattering process. On the other hand, the dye laser pulse can not raise the temperature of sample more than 1°C.

ACKNOWLEDGEMENTS

We would like to thank Prof. C. Klingshirn for CdS samples. We are also specially grateful to Mr. Wei Changjiang for the help of experiments.

REFERENCES

1. M. Dagenais and W.F. Sharfin, Appl. Phys. Lett. 45 (1984) 210.

2. X.W. Fan and J. Woods, Phys. Stat. Sol. (a) 70, 325 (1982).

Journal of Luminescenc
North-Holland, Amster

PICOSECOND COH

J.M. HVAM, I.
Fysisk Institu

Time resolved
the free excit
nance, we dete
ties, the phas
and temperatur

1. INTRODUCTION
Picosecond coh
experiments have
mining the phase
molecules and rec
where it is of pa
gap materials[2,3]
an incident light
tronic excitation
In a degenerat
riment, the inter
beam relative to
third order nonl
From the correlat
signal, i.e. the
the delay betwee
pulses, we are a
coherence time f

2. EXPERIMENTAL
The DFWM expe
grown ≈20μm thic
source was a syn
dye laser. The o
exponential shap
spectroscopic li
maximum intensit
and was reduced
were polarized p

*Work supported

0022-2313/88/$03.5
(North-Holland Physi