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TRANSIENT STATE STUDY OF THE POLARIZATION PROPERTIES OF SIDEBAND RECOMBINATION EMISSIONS IN GaN CRYSTALS

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In this paper, we report that the polarizabilities of near sideband recombination emission I_1 and I_3 in GaN crystal change quadratically with density of bound excitons.

1. INTRODUCTION

Exciton-exciton interaction has been an interesting problem for a long time. With the use of high power and short pulse Laser, intensity exciton system can be easily produced in crystals. This provides a basic experimental way to study interaction between excitons.

We analysed interaction between excitons and presented dispersion conception of exciton-exciton from dipole interaction[1,2].

We had reported the experimental result of polarization properties of sideband recombination emission in GaN crystal, with steady state spectra technique[3], which give a proof for dispersion theory.

The transient polarization properties of near sideband recombination emission peak I_1 and I_3 in GaN crystal were experimentally studied with decay spectra technique and our results are reported in this paper. According to the result reported by Prof.Dai Rensong et al.[4] that peak I_1 from recombination emission of BE^0 and I_3 from BEA^0.

The results of transient spectra agree with our previous results of steady state experiments and provides an experiment proof for the dispersion theory of exciton-exciton interaction.

The excitation intensity in our experiments was $1.2\times10^5 W/cm^2$, time precision was 10 ns and the temperature was 77 ± 0.5 K.

2. EXPERIMENTAL SET-UP

An excimer laser EMG-102 was used as excitation light source. Its light quantum energy was 4.023 eV and the peak power can be changed from 0 to $10^8 W/cm^2$ by a group of attenuators. The pulse width was 10 ns. The samples were put in the cryostat ESR-900. A polarizer was put before a double grating monochromator to pick out bound exciton emission polarized in parallel and prependicular directions to the C-axis of GaN wafers respectively. After the monochromator, the light signal was amplified by a photomultiplier C31034 with cooling system. The amplified signal was then sent to Boxcar M-162, and then to an X-Y recorder.

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3. EXPERIMENTAL RESULTS

We studied two kinds of samples, one was unintentionally doped GaN crystal, a typical sample was labeled by GaN-15#, the other was Zine doped GaN crystal, a typical sample was labeled by GaN-16#. We recorded the decay spectra of I_1 and I_3, in two directions, that is, $I_{\parallel}$ and $I_{\perp}$, where $I_{\parallel}$ and $I_{\perp}$ are the luminescence intensities parallel and perpendicular to C-axis of GaN crystal, respectively. The experimental results for GaN-15# and for GaN-16# are shown in Fig.1 and Fig.2 respectively.

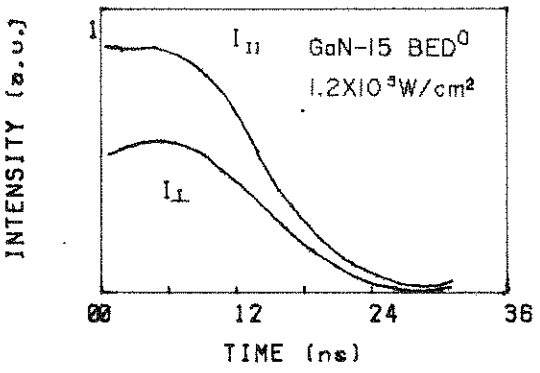

Fig.1 Decay spectra of GaN-15#

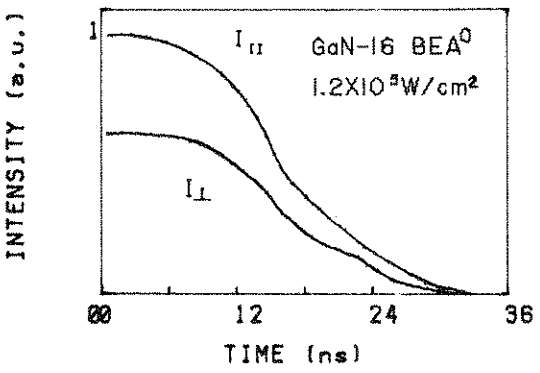

Fig.2 Decay spectra of GaN-16#

The polarizability of bound exciton emission P is defined as follows:

$$P(t) = I_{\parallel}(t)/I_{\perp}(t) \qquad (1)$$

The following expirical formula $P(t)=(A+B*b(t))^2$ was obtained from our experiment results.

The relation between $P^{\cdot 5}$ (t) and b is shown in Fig.3.

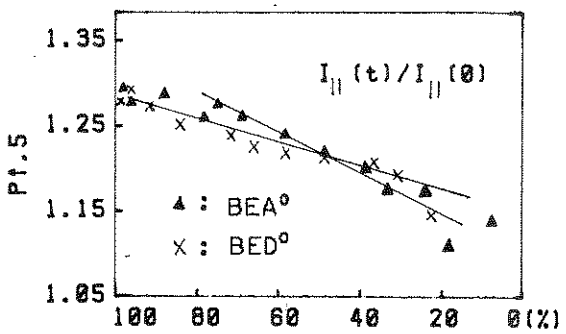

Fig.3 The relation between $P^{\cdot 5}$ (t) and b

4. CONCLUSIONS

These results supported our previous conclusions presented for exciton-exciton interaction.

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