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Observation of Deep Levels in Semi-insulating GaAs by Optically Stimulated Current and Thermally Stimulated Current

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Deep levels in SI GaAs should be fully understoood and controlled before the material shall be widely used. DLTS is not easily applicable to SI GaAs because of high series resistance.

We report the utility of thermally and optically stimulated current(TSC & OSC) for the estimation of the levels and concentration of traps.

Samples were thinned to  $2 \,\mu$ m at the center. The back electrode was made with evaporated Al. The front electrode was with semitransparent Al surrounded by a guard ring to prevent surface leakage.

Thermally stimulated current was measured(Fig. 1). The sample was exposed to white light at 12 K as initialisation. Roughly estimated levels are shown in the figure. From the area of the peaks we can also estimate the trap densities. Some sophistication can tell electron traps from hole traps. At present we can observe levels up to 0.7 eV.

In order to observe the deeper level of EL2, we resorted to OSC as shown in Fig. 2. In (a)  $5 \times 10^{16}$ Si cm<sup>-3</sup>LEC GaAs, and (b) SI LEC GaAs, spectral peak near 1.1  $\mu$  m is observed. We postulate the peak is due to EL2 from the photoquench effect shown in Figs. 3 and 4.

Thick sample of n-GaAs is initialised by applying forward voltage. With application of reverse bias, photocurrent to 1.13 eV photons is seen to decay with time as in Fig.3 a), and the decayed state remained with reverse bias, b). Forward biasing brings the sample back to the initial state as shown in Fig. 3 c). This photoquenching effect has a temperature dependence as shown in Fig. 4. Decay time constant decreases with the increase of temperature, and the photoquenching disappears at 140 K.

These observations are in accord with those by Vincent et  $al_{\cdot}^{(1)}$  on EL2 by means of photocapacitance method.

In conclusion we report the utility of TSC and OSC for the study of deep levels in SI GaAs at low temperatures. 1) G. Vincent et al., J.appl. Phys. 53, 3643(1982)



Fig. 1. TSC Spectrum of SI GaAs



Fig. 3. Photoquench of OSC in n GaAs with(a & c) and without(b) initialisation



Fig. 2. OSC Spectra of a) n GaAs and b) SI GaAs



