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Determination of the Active Region in Light-Emitting GaAs Diodes

Stimulated emission has been observed recently in GaAs diodes.[1] A question of particular interest is the spatial origin of the light. In this Letter it is shown that in high-efficiency units the light clearly comes from the *p*-region. This is in agreement with the conclusion from fluorescence measurements on homogeneously doped samples of GaAs that an acceptor center is involved in the radiative recombination in *p-n* junctions.[2] Furthermore in a rectangular parallelepiped laser[3,4] it is found that the appearance of the emitting region does not change as the current is increased above the threshold for stimulated emission.

The problem was investigated by taking photomicrographs of diodes. For room-temperature measurements, the units were embedded in epoxy resin, polished and etched to reveal the junction. At 77°K the untreated surfaces of the laser were observed.

Figure 1 is a photomicrograph of the snooperscope image of a diode at room temperature with 2 ma flowing through the diode. The square structure is the GaAs diode, which is mounted on a metallic tab A. The bright line B-B′ is reflected incident light from the etched *p-n* junction. The area C is the indium dot contact to the *p*-region D. The emission is clearly visible as the light area just above the *p-n* junction. It can be seen that the emission is somewhat more intense close to the junction and that the active region is about 15 μ thick.

In order to preclude the possibility that the light is generated at the junction and shines through the *p*-region, angled cross sections were made such that the projection of the junction on the surface of observation falls on the *n*-side. No significant difference in the patterns of the illuminated region was observed. This experiment also shows that the observed light is generated close to the surface.

Figure 2 shows the results obtained from a rectangular parallelepiped structure at 77°K. Figure 2a indicates the geometry of the diode and the surface which was photographed. Figure 2b is a photomicrograph with background light only. Figure 2c is taken below the threshold for stimulated emission, and Figure 2d is taken above the threshold.

It is seen that the illumination of the active region appears to be by no means uniform. Some of this non-uniformity is caused by surface irregularities. It is clearly evident, however, that the pattern is almost identical in the two photographs. This indicates that the volume of the light-emitting or active region does not change when the current is raised.

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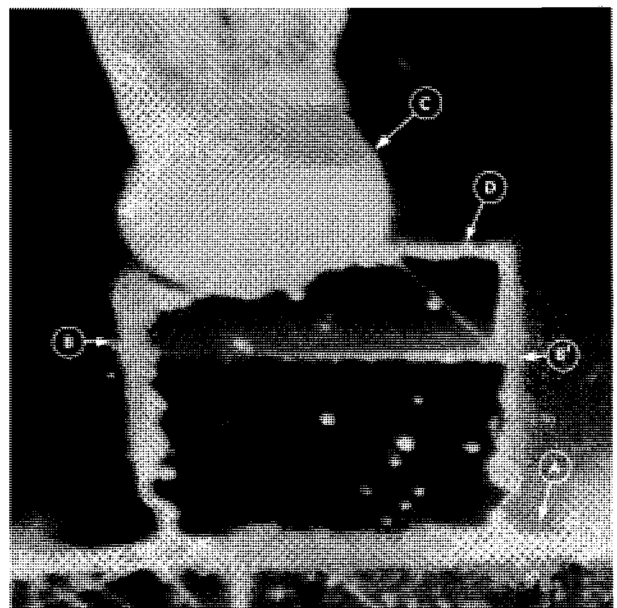
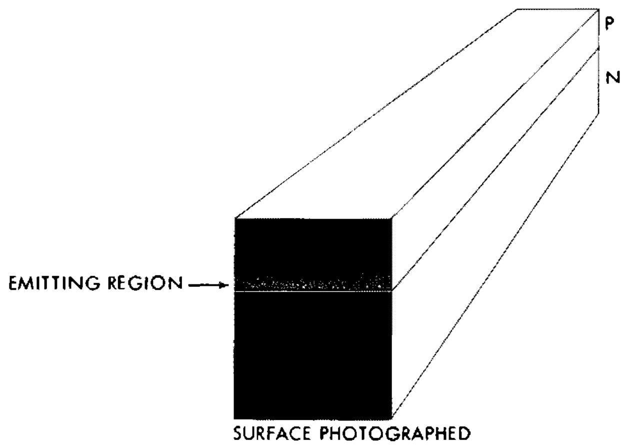
Figure 1 **A room temperature photomicrograph of a GaAs light-emitting diode.**
The width of the diode is 160μ.





(a)

(b)

(c)

(d)

Figure 2 **Results obtained at 77°K:**
a) Schematic, illustrating geometry; b) background light, no current; c) current below threshold, ten 60 nsec, 8 amp pulses; d) current above threshold, three 60 nsec, 12.5 amp pulses.

References

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