

Injection Mechanisms in GaAs Diffused Electroluminescent Junctions

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Injection mechanisms responsible for the electroluminescence in GaAs diffused diodes are studied by examining the behavior of the emission peaks as a function of injection level, doping level, temperature, and depletion-layer widths. Three different injection mechanisms seem to be operative in providing radiation at near-band-gap energies. Models for two of these are proposed and tested. The nature of the third emission remains an open question.

I. INTRODUCTION

MOST of the recent investigations on the recombination radiation from GaAs p - n junctions are concerned with the nature of the radiative transitions which follow the injection process.¹⁻⁷ In this article we apply ourselves to the injection process itself and present experimental evidence demonstrating the existence of three distinct injection mechanisms in narrow degenerate junctions.

Another purpose of this paper is to fill in the details, both experimental and theoretical, which were, by necessity, left out of two previous short communications.^{8,9}

The paper is not concerned with injection processes in general, but only with those processes associated with radiative transitions. The most direct measure of the importance of each injection process is the total (integrated) intensity of the recombination radiation rather than the total current. This is particularly important when a number of injection mechanisms leading to the same or different recombination processes co-exist and/or when, due to the presence of nonradiative processes, the fraction of injected carriers which leads to radiative transitions varies with injection level.

Now a few comments on the correlation between the generated spectra and the externally observed ones. The radiation is generated in a very narrow region near the depletion layer and the wavelength of the emission is

very near the absorption edge of the material. As the emitted radiation travels along the material, the spectrum is distorted by a higher absorption in the high-frequency side of the emitted line. A complete correction for this spectral distortion is not always easy because absorption data for different dopings are not easily available and because, due to possible internal reflections, different optical properties within the space charge region, and guiding effects along the junction,^{10,11} it is impossible to evaluate properly the effective path traversed by the radiation.

In order to avoid those spectral distortions, we have observed the high-frequency emission by three different methods. (1) Some diodes had most of the p side removed and a polished gold window permitted most of the radiation to come out from the p side. In order to avoid back reflection from the n side (which would reinforce the low-frequency part of the emission),¹² an absorbing p layer was diffused on the n side (Fig. 1).

DIODE STRUCTURE

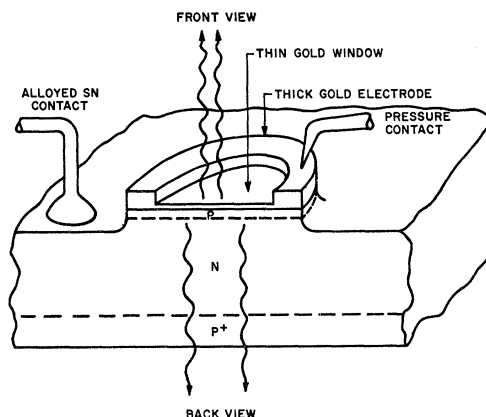


FIG. 1. Diode structure for most of the diodes used in this work.

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