DIFFUSION OF IMPURITIES

IN SEMICONDUCTORS

BY

Y.R. ANANTH PRASAD

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G C Jain

(G.C. JAIN)
NATIONAL PHYSICAL LABORATORY
NEW DELHI-12

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ABSTRACT

The process of diffusion leads to a deterioration in the lifetime of the minority carriers. An explanation for this phenomenon has been advanced, whereby it is assumed that the gradation of impurity atoms gives rise to a built-in electrostatic field and field gradient. The presence of a field gradient affects the charge density at any point which in turn affects the minority carrier lifetime.

It has been shown that for the normal impurity profiles obtained in practice, both the electrostatic field and field gradient exist. Further, the presence of a field gradient precludes the existence of space-charge neutrality. An experimental confirmation of the theory, has been obtained by measuring the parameters of sheet conductivity and the minority carrier lifetime in a thin layer near the surface at different points on the diffusion profile. The experiment has been carried out for phosphorus diffusions into a boron doped substrate. Both the modes of diffusion namely diffusion from an infinitesmally thin source, and diffusion from a constant dopant source have been checked.

The results indicate a positive confirmation of the field gradient theory.

In the second part of the work, the effect of built-in electrostatic fields and field gradients on the performance of P-N junctions has been considered. It has been shown that while an increasing electrostatic field reduces the reverse saturation current, an increasing electrostatic field gradient has just the opposite effect. The variation of reverse leakage current with electrostatic field gradient has been measured experimentally. It has been concluded that the ideal profile would be one which would give rise to an electrostatic field, but would have no field gradient. The profile which fits this specification is the exponential profile. Possible methods of obtaining an exponential profile have been discussed.

C O N T E N T S