Temperature dependent IBIC study of 4H-SiC Schottky diodes

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It is well known from the Shockley-Ramo-Gunn theorem, that IBIC signals stem from the motion of charge carriers in regions where the electric field occurs. In rectifying devices, carriers generated in the neutral region can contribute to the induced charge signals if they are injected by diffusion into the depletion layer. The weight of such a contribution depends on the “probability” they can reach the active layer, which is an exponential function of the distance of the generation point from the edge of the depletion layer with a rate equal to the diffusion length of minority carriers.

Such a basic transport parameter can be evaluated by fitting with a simple unidimensional model the charge collection efficiency curve vs. the applied bias voltage (i.e. the extension of the depletion layer). Moreover, by performing IBIC measurements at different temperatures, more detailed information can be extracted on the nature of the phenomena limiting the carrier transport.

Finally, the homogeneity of the electronic quality of the device can be obtained by mapping directly the minority carriers diffusion lengths (or the relevant mobilityxlifetime product) instead of the commonly adopted charge collection efficiency.

In this paper we report on IBIC analysis of epitaxial 4H-SiC Schottky diodes [1] performed in a temperature range of 77–500 K. The samples were irradiated by focused 1.5 MeV proton microbeams and the induced charge signals were recorded at different bias voltages and different temperatures. IBIC maps show a significant inhomogeneity of the charge collection response; the analysis of such a response at different temperatures show a non monotone behavior of the (mobility x lifetime) product.

[1] F. Nava *et al.*, Nucl. Instr. and Meth. in Physics Research A 510 (2003) 273–280.