Development of Switching Characteristic of Non-Punch Throug Insulated Gate Bipolar Transistor by Fast Neutron Irradiation

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The insulated-gate bipolar transistor (IGBT) is a unique device that combines the low forward voltage drop of a bipolar junction transistor (BJT) and the high input impedance and fast switching of a metal oxide semiconductor field effect transistor (MOSFET). But, turn-off delay time of the IGBT is increased by the tail-current due to stored minority carrier in n-drift region when the device is turned off. Also there is a disadvantage that the reverse current becomes large and power loss increased. These power losses which is the biggest factor that reduces the energy efficiency of the IGBT. To improve this, recently research has been conducted to improve the switching speed by controlling the lifetime of minority carriers of IGBT. A lattice defect is intentionally formed in n-drift region of the IGBT so as to act on a deep energy level in the energy band. These deep energy levels acts as minority carrier recombination centers and control the lifetime of the minority carrier in the IGBT to minimize the turn-off delay time.

In this study, the NPT-IGBTs were irradiated by fast neutrons from the MC-50 cyclotron at the KIRAMS (Korea Institute of Radiological & Medical Science). Fast neutron irradiation with various doses of energy have been carried out into IGBTs as a wafer state. The electrical characteristics, such as threshold voltage (V_{TH}), on-state forward voltage drop (V_{CE}) and Switching time were analyzed and compared with non-irradiated.

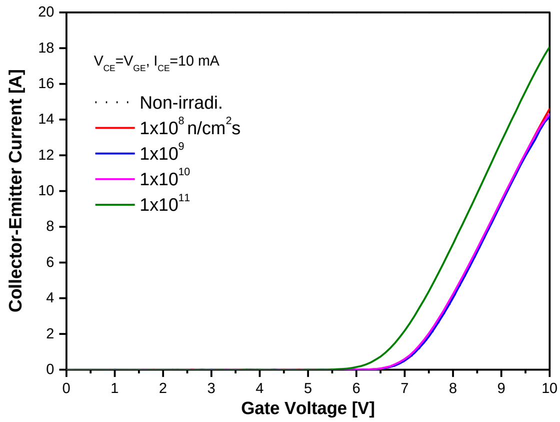

Fig. 1. Gate-emitter voltage and collector-emitter current curves for each irradiation dose

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