B — 6 — 9* GaAs P-N Junction Formation by Carbon Ion Implantation

Yoh Mita, Noriaki Tsukada, Masafumi Hashimoto and Shigeru Semura
Optoelectronics Joint Research Laboratory,
Nakaharaku, Kawasaki, 211, Japan

It has been shown that GaAs p-n Junction with good rectifying characteristics can be obtained by implanting carbon ions into n-type GaAs crystal. The sheet resistivity for the p-layer thus formed was seen to reduce markedly when GaAs crystals were previously implanted with boron ions.

Although carbon ion implantation into GaAs has been known to form a low resistive p-layer, when implanted with Ga ions,[1][2] heretofore there have been no reports made on the application to p-n junction formation. Unlike Zn, Mg or Be ions, which have been utilized for this purpose, carbon ions can be obtained from gas source, are non-toxic and have a larger projection range, compared with Zn and Mg.

Carbon ion implantation was carried out at 100 to 200 keV energy with an ion dose of $10^{14}cm^{-2}$. Vapor-phase grown epitaxial GaAs crystals 3 μm thick with $2 \cdot 10^{15}cm^{-3}$ electron density were principally adopted for n-type substrates. Most of the crystals were previously implanted with boron with doses ranging from 10^{14} to $10^{15}cm^{-2}$ at an energy that gave rise to comparative projected range with carbon ions. The crystals were coated with SiO_2 films obtained with pyrolytic or plasma CVD methods and annealed at a temperature of 800° C for 20 minutes in an N_2 stream. Sheet resistivity and diode characteristics measurements were performed after preparing Au-Zn electrodes and Au-Ge back electrodes.

Typical results obtained on sheet resistivity are shown in Fig.1, taking annealing temperature as the abscissa and implanted boron density as the parameter. It can be seen that the conductivity values increase with boron density, just as reported by previous investigators on gallium implantation[1][2]. At still higher boron implantation densities, however, higher temperature is required to anneal the crystals, reflecting slower recovery from heavy radiation damage. The experimental results given above strongly suggest that the boron atoms incorporated into gallium sites affect the crystal stoichiometric composition in the same way as implanted gallium atoms.

A representative result on diode characteristics is shown in Photo 1. Breakdown voltage was measured as high as 75 V, which is comparable to the value calculated from avalanche breakdown in an abrupt junction.

Experimental findings obtained here seem to make carbon implantation tech-

nique a useful method to fabricate GaAs p-n junction along with Be or Mg implantation.

(1) B. K. Shin, J. E. Ehret, Y. S. Park & M. Stefiniw: J. Appl. phys. 49, 2988 ('78).

(2) H. Kräutle: Nuclear Instrum. Method 182/183, 625 ('81).

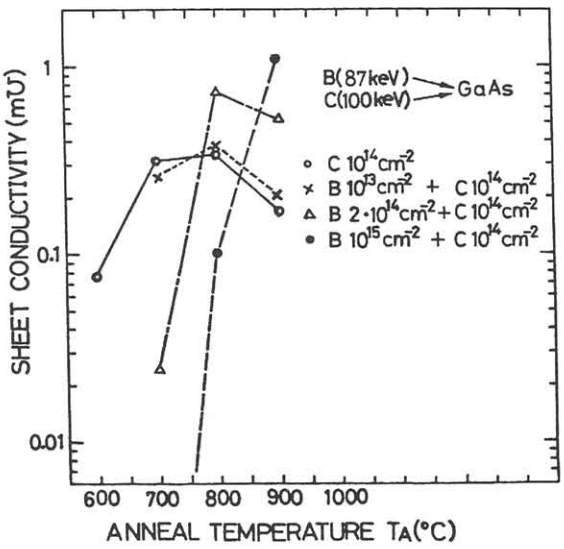

Figure 1 P-layer sheet conductivity for diffeent annealing temperatures

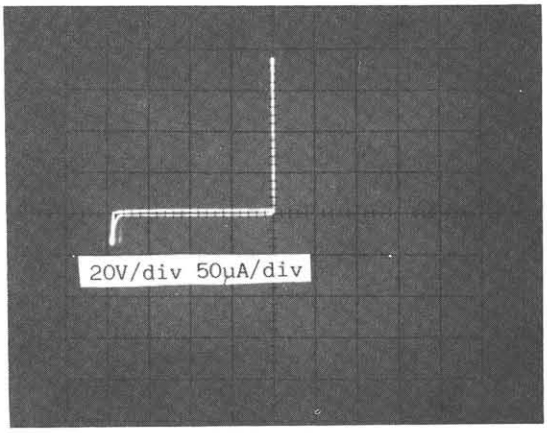

Photo 1 V-I characteristics for typical GaAs p-n junction diode