NASA TECH BRIEF
Langley Research Center

GaAs Transistors Formed by Be or Mg Ion Implantation

The n-p-n transistor structures have been formed in GaAs by implanting n-type substrates with 45-keV Mg or 40-keV Be ions to form the base regions and then implanting them with 20-keV Si ions to form the emitters. SiO_2 films, sputter deposited at room temperature, are used as implantation masks to define the lateral geometry of the transistors. Because Mg and Be are light ions they penetrate more deeply into the lattice for a given ion energy and hence are particularly useful in applications where a relatively thick doped layer is required.

The p-type layers have been produced in GaAs by implantation of either Mg or Be ions, with the substrate at room temperature, followed by annealing at higher temperatures. The ion source in both cases was a hot-cathode electron-bombardment type. The Mg ions were generated by placing metallic magnesium in an axial probe inserted into the source, while the Be ions were produced by placing $BeCl_2$ in the probe. The n-type <111> substrates were implanted with 45-keV Mg or 40-keV Be ions and subsequently annealed for 15 minutes at temperatures up to 900° C. The dependence of surface carrier concentration and mobility on ion dose, and on post-implantation annealing temperature, was determined using the van der Pauw-Hall technique.

The GaAs substrates were <111> oriented wafers (± 3°) with the β-face chemically polished prior to implantation. The wafers were intentionally misaligned 8°, with respect to the ion beam, during implantation to minimize ion channeling. Implantation was performed with substrates at room temperature. Treated substrates were subsequently coated with a sputtered layer of SiO_2, 200 nm thick, prior to annealing at higher temperatures in a flowing N_2 atmosphere. This oxide coating has been found effective in preventing dissociation of the GaAs as well as in reducing outdiffusion of the implanted ions during annealing.

The results show that Be and Mg can be used as ion-implanted dopants in GaAs, producing p-type layers with reasonably large hole concentrations. Hole mobilities are in the range 100-200 cm^2/V sec.

Note:

Requests for further information may be directed to:

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NASA has decided not to apply for a patent.

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