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PROTON-ENHANCED DIFFUSION OF As IN Si FROM A DOPED POLYCRYSTALLINE SOURCE (DOPOS)*

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Nakayama et al.[1] recently reported on the use of an arsenic-doped layer of polycrystalline silicon (DOPOS) as a convenient diffusion source for fabricating As emitters in microwave bipolar transistors. An important advantage of such a source is that subsequent processing steps required to form ohmic contact to the emitter are greatly simplified (as compared to those normally used with conventional diffusion sources). The purpose of this paper is to describe experiments which have been carried out to study the suitability of DOPOS as a diffusion source for the proton enhanced diffusion process.[2] The motivation for these experiments was to combine the special advantages of DOPOS with those of proton-enhanced diffusion (accurate doping profile control and relatively low substrate temperature for diffusion) for the fabrication of improved emitters.

The experiments to be discussed in the paper were performed as follows. A DOPOS layer of thickness 2000 Å, having an As doping concentration of approximately 10%, was deposited on a boron-doped Si wafer in a suitably operated epitaxial reactor. The sample was then heated to 750°C and exposed to a 20 na/cm^2, 50 keV proton beam for one hour. Following this treatment, nuclear backscattering measurements were made to determine the total As concentration in the parent wafer as a function of depth; and sheet conductivity and Hall effect measurements were made to determine the electrically active As concentration. In both cases the impurity density was found to have a value of $\sim 7 \times 10^{19}$/cm^3 at the original Si surface, and to decrease gradually to a value of $\sim 2 \times 10^{19}$ at a depth of approximately 1000 Å. Beyond this point the impurity profile drops abruptly. Control samples obtained by simply masking the beam from a portion of the sample showed no As diffusion into the parent wafer.

Results obtained from these experiments will be presented in detail, together with the electrical characteristics of the junction diodes formed by the As diffusion.

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1. Nakayama et al., paper delivered at ECS Fall Meeting, Miami, Florida, October 1972 (Abstract No. 264).

2. See, for example, Minear, Nelson, and Gibbons, Journal of Applied Physics 43 (8), 3468 (1972).