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Selectively Grown Non-Alloyed Ohmic Contacts to n-GaAs

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GaAs LSI process technologies have shown a lot of advances, and the LSIs with higher packing density and higher speed operation have been realized. However, there has been no advance in the field of ohmic metalization in GaAs LSI process. At the present stage, most widely used metal for ohmic contact is AuGe/Ni. This electrode has various disadvantages, that is, poor morphology, the lacking of etching method, and necessity of alloying process.

In this late news, a newly developed ohmic contact to n-GaAs, which can be formed by selective growth on GaAs using SiO_2 as a mask and which can show ohmic characteristics without any alloying or sintering process, is presented. The selective growth technology is considered to have great advantage to widely used AuGe/Ni in the view point of planarization, self-alignment, and fine pattern applicability. To realize the new ohmic contact, n^+-Ge epitaxial growth on GaAs using low-pressure CVD technique is adopted for the first time.

The experimental equipment is a lamp-heated horizontal reactor with load-lock system as shown in Fig 1. Source gases were GeH_4, H_2, and PH_3. No additional species were used. Ge on GaAs was grown with the low-pressure of $4x10^{-3}$ atm, which was measured with a MKS Baratron gauge. Ge growth is possible at the relatively low temperature of 350°C-480°C, which was measured with an optical pyrometer. Substrates used here were (100)-oriented, non-doped, LEC-grown GaAs wafers. The GaAs substrate was etched with a solution of H_2SO_4, H_2O_2, and H_2O. Then HCl was used to remove native oxide. Ge growth was carried out in the surface reaction range. This is confirmed by growth rate dependance on temperature and the growth rate dependance on GeH_4 flow rate(1). Figure 2 shows the PH_3 flow rate effect on Ge growth rate. A little increase of PH_3 flow rate decreases the growth rate rapidly. Similar effect is observed for P-doped poly-silicon deposition(2). This is because that PH_3 molecule easily adsorbs Ge surface and prevents GeH_4 adsorption. The addition of PH_3 makes it possible to realize $1x10^{19}$ cm^{-3} doping concentration. The doping level is enough high to obtain non-alloyed ohmic characteristics which is shown in Fig.3. Contact resistivity was 10^{-5} $ohm*cm^2$, which was measured using TLM. This report on non-alloyed ohmic contact fabricated with CVD technique is the first one. The selective growth result of Ge on GaAs is shown in Fig.4. To make the selective growth clear, the former part of Ge was removed after Ge growth. The step of Ge in the SiO_2 groove and no deposition on SiO_2 is clrealy shown.

In summary, P-doped Ge growth on GaAs using CVD is successfully realized in the range of low temperature and low pressure. According to this investigation, a novel process for non-alloyed ohmic contact is enabled. This newly developed process makes it possible to form ohmic electrode selectively. Selective growth of non-alloyed ohmic electrode is considered to have great advantage for planalization, self-alignment, and fine pattern applicability.

REFERENCES

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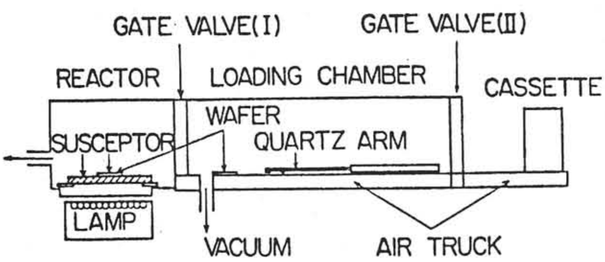


Fig. 1 Schmatic diagram of experimental apparatus.

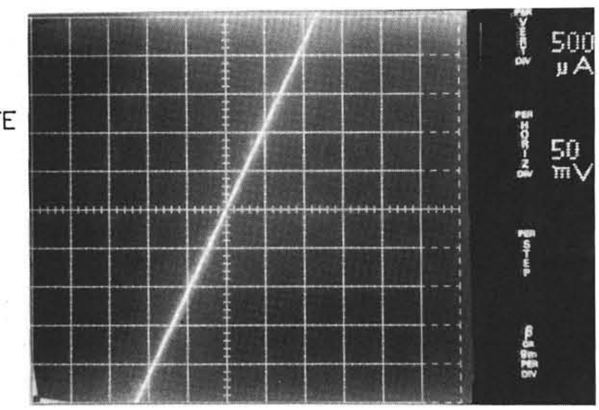
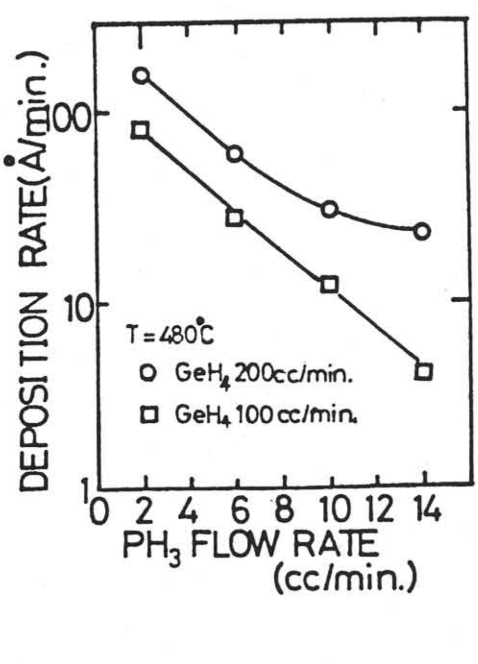


Fig 3 Non-alloyed ohmic characteristics. Contact metal was Au.



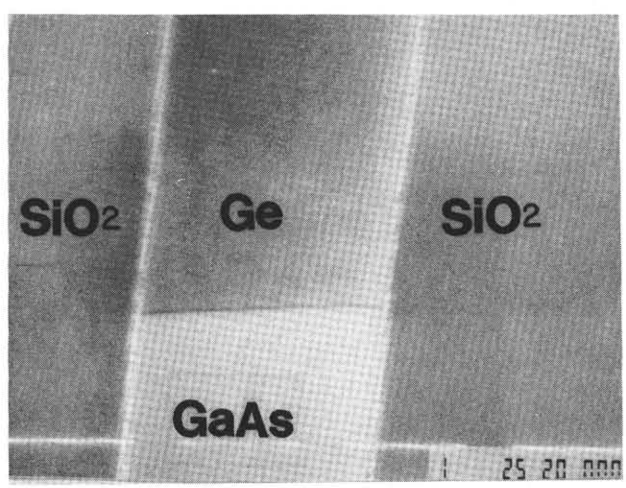


Fig.4 Selective growth of Ge on GaAs with SiO_2 mask.

Fig. 2 Ge growth rate dependance on PH_3 flow rate.