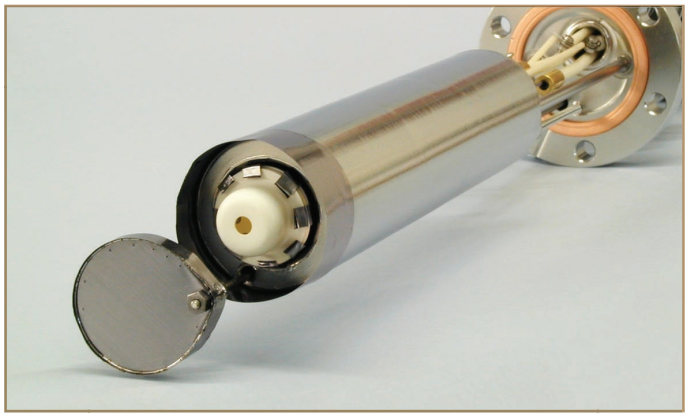
P-Doping Source for Si/SiGe MBE DECO-D



DECO-D 40-10-KS, GaP compound source for P-doping on DN40 CF (O.D. 2.75“) flange.

- **10^{20}/ccm n-type doping in Si/SiGe MBE**
- **P-doping through GaP decomposition**
- **High P incorporation rate**
- **Minimum memory effects**
- **Easy to install and to operate**
- **Sharp doping profiles**
- **Precise and fast flux control**

The DECO-D is an ultra pure source for P_2 based on the decomposition of GaP.
At typical operation temperatures of about 600°C - 700°C GaP is essentially decomposed to Ga and P_2. Additional cracking is not necessary and the accumulation of P_4 (white Phosphorus) is reduced to a minimum.

The all PBN Ga-Trapping Cap Unit of the DECO-D allows the escape of P_2 molecules from the cell while trapping parasitic Ga atoms efficiently. The very low parasitic Ga flux is more than three orders of magnitude lower than the P_2-flux.

The DECO-D is as easy to operate as a standard group III effusion cell due to its high operation temperatures. This results in stable and reproducible flux adjustments.

The cell is equipped with a specially designed shutter which allows to grow sharp δ-doped epi-layers (see Fig.1 and 2 below).

Fig. 1 shows a I-U characteristic with a record high peak-to-valley current ratio of a Si/SiGe Esaki diode. The data are from ref. [4] R. Duschl et al. measured at the Max-Planck-Institute FKF in Stuttgart.

Fig. 2 shows a SIMS profile of a sharp p-n junction in a Si/SiGe/Si Esaki diode device. The structure was grown at the Max-Planck-Institute FKF in Stuttgart, in the group of Dr. O. Schmidt.

Fig. 3 shows a sharp P-doping profile in a Si layer with two P-δ-layers. The experiment was performed at the Universität der Bundeswehr in Munich, in the group of Prof. Eisele.

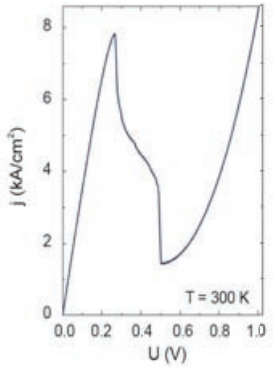


Fig. 1: I-U characteristic of a Si/SiGe Esaki diode measured by R. Duschl et al. at the MPI Stuttgart, ref. [4].

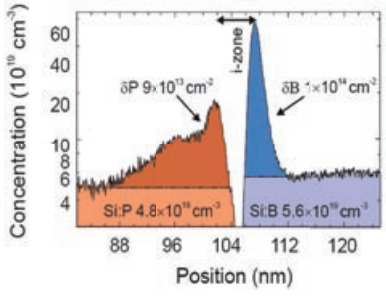


Fig. 2: SIMS profile of a Si-based Esaki diode with sharp p-n junction. The structure shows a record high peak-to-valley current ratio.

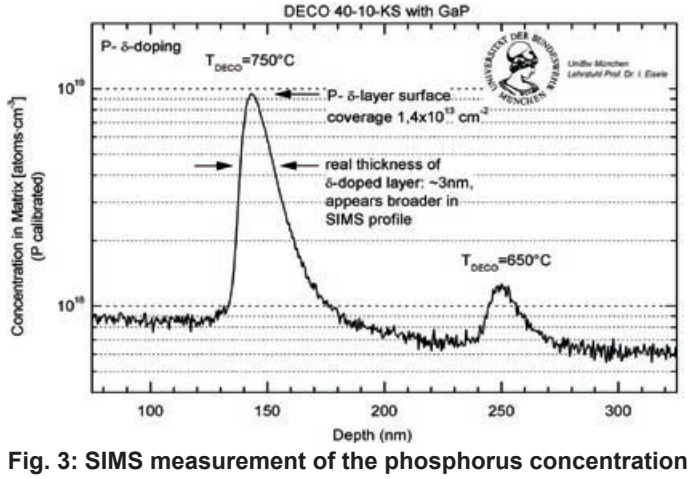


Fig. 3: SIMS measurement of the phosphorus concentration for P-δ-layers deposited at different source temperatures on Silicon.

Applications

High level and sharp δ–doping with Phosphorus in Si/SiGe MBE. Small crucible charges, large double layer shutters, integrated water cooling and reduced shielding allow a fast shutdown of the cell after the doping. High 10^{20}/ccm doping and sharp δ–doping have been reported in literature applying the DECO-D from MBE-Komponenten GmbH.

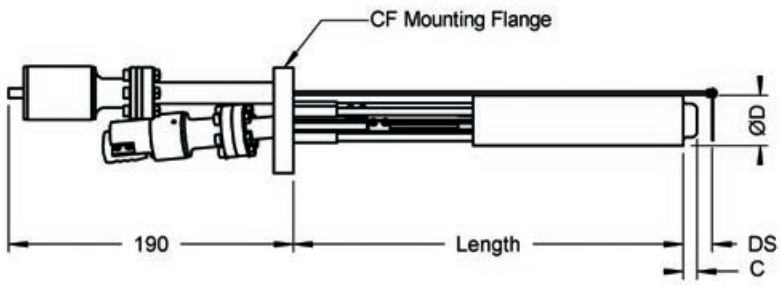
Due to its small dimensions and easy operation the DECO-D is ideally suited for all types of MBE systems.

Technical Data

Mounting flange	DN40 CF (O.D. 2.75") or larger
Dimensions in vacuum	Length 220-400mm (user specific)
Filament type	Ta wire heating filament, optimized for doping application
Thermocouple	W5%Re/W26%Re (type C)
Bakeout temperature	300°C
Operating temperature	500-800°C for doping sources
Outgassing temperature	1500°C
Crucibles	5-35 cm³; PBN crucibles
Options	integrated water cooling shroud (**K**), integrated shutter (**S**);

Schematic drawing of the GaP compound source DECO-D

(Drawing shows DECO-D 40-35-S)



References

Doping application:

[1] Heavy phosphorus doping in mbe grown silicon with a GaP decomposition source G.Lippert et al., Appl. Phys. 66 (23) 3197 (1995)
[2] P-δ-doping in Si MBE C.Tolksdorf, I.Eisele, Uni-BW Munich, to be published
[3] R. Duschl et al.; Thin Solid Films 380 (2000) 151.
[4] R. Duschl et al.; Appl. Phys. Lett. 76 (2000) 879.

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