

VALVED GaP COMPOUND SOURCE VGCS



VGCS 100-420, valved GaP compound source on DN100 (O.D. 6") mounting flange with 420 cm³ crucible

The Valved GaP Compound Source VGCS is a high purity phosphorus (P_2) source, based on the decomposition of high purity GaP. The concept is derived from our DECO effusion cells to which a reliable mechanical valve mechanism is added for rapid beam flux control.

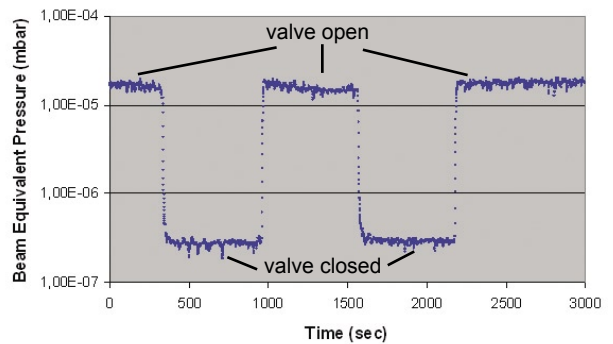
Full MBE compatibility is reached by the integrated Gallium-Trapping-System, the integrated water cooling as well as the use of high purity inert materials such as pyrolytic boron nitride (PBN) or Tantalum for all parts in the direct phosphorus path.

In contrast to sources using elemental phosphorus only minor amounts of white phosphorus are formed within the cell. The formation of white phosphorus within the MBE chamber is significantly reduced due to the direct formation of P_2 species from the decomposition of single crystal GaP chunks with purity 6N-7N.

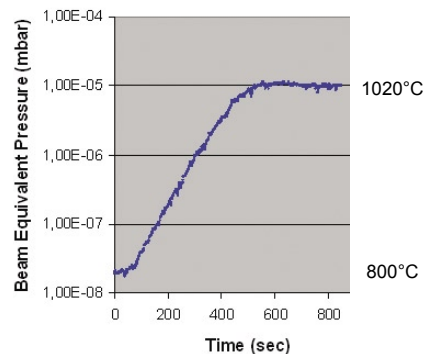
Operation of the mechanical valve unit shows fast, stable and reproducible flux control. The wide angle cone valve mechanism with its large cross section allows improved pumping of the GaP reservoir and excludes valve sticking. Together with our valve controller an easy handling and integration to your MBE system is provided.

High purity of GaInP layers grown on GaAs is demonstrated by SIMS measurements (see figure on the right). The contamination of the GaInP layer with oxygen and carbon is below the detection limit of about $5 \times 10^{16} \text{cm}^{-3}$ using highest purity single crystalline GaP source material.

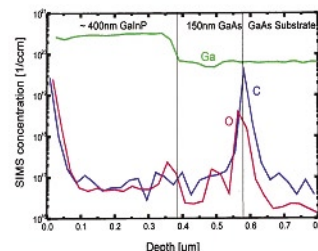
- Produces pure P_2 species ($P_2/P_4 > 150$)
- Large crucible capacity of 420 cm³
- Reliable large cross section cone valve
- Fast, stable and reproducible flux control
- Safe cell loading and operation
- No hot cracker zone
- Injector length and flux distribution adjustable to fit most MBE systems



Beam equivalent P_2 pressure vs. time, with valve closed/open



BEP during ramp 800°C to 1020°C (valve open), flux can be adjusted within minutes due to high reservoir temperature



SIMS measurement of a GaInP layer grown on GaAs

Applications

The VGCS is designed for growth of phosphide compounds in III-V-MBE. It has been readily approved in industrial applications. The fast and reproducible flux control using a valve allows the growth of phosphide-arsenide heterostructures with very sharp interfaces like quantum wells and superlattices. It is perfectly suited for applications in HEMTs, HBTs, GaAlInP laser diodes and other devices. GaInP/InP quantum dot lasers have been prepared. The large crucible size makes the VGCS well suited for MBE research and production systems.

Motorized Valve Control Unit

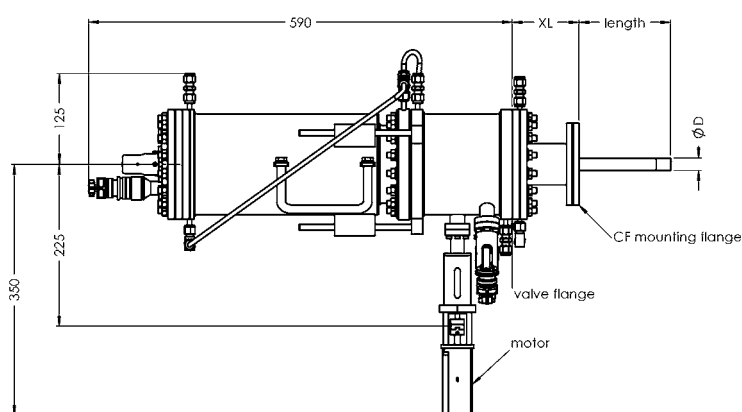
The Motorized Valve Control Unit MVCU is designed for operating the valve of a valved source with a servo motor drive. Manual or remote control with 0-10 V analogue input signal is possible. The display indicates the linear position of the valve from 0 - 7.99 mm from fully closed to fully open position. The servo motor drive has a resolution of 0.01 mm/step and a high motor speed of 10 mm/s. The automatic zero calibration guarantees a highly reliable and reproducible operation of the valve unit.

The MVCU housing is compatible with the 19" rack system.

Technical Data

Mounting Flange	DN100CF (O.D. 6") [DN40CF (O.D. 2.75") or DN 63CF (O.D. 4.5") with VADP adapter]
Heating system	2 separate heater circuits (cell/valve)
Thermocouple	2 Type C W5%Re/W26%Re thermocouples (cell/valve)
Bakeout temperature	300°C
Operating temperature	cell crucible: 800-950°C; valve: 350°C
Outgassing temperature	cell crucible: 1300°C; valve: 500°C
Cooling	integrated water cooling shrouds
Crucibles	420 cm ³
Flux control	integrated valve unit / cell temperature
Valve control	servo motor drive with control unit MVCU

Schematic drawing of the Valved GaP Compound Source VGCS
(Drawing shows VGCS 100-420 with VADP adapter)



References for GaP decomposition source and valved GaP compound source grown devices:

- [1] M. Missous, A. A. Aziz, A. Sandhu; Jpn. J. Appl. Phys. 36, L647 (1997)
- [2] M. K. Zundel, N. Y. Jin-Phillipp, K. Eberl, T. Riedl, E. Fehrenbacher, A. Hangleiter; Appl. Phys. Lett. 73, 1784 (1998)
- [3] Y. M. Manz, O. G. Schmidt; Mat. Res. Soc. Symp. Proc. 722, 325 (2002)
- [4] Y. M. Manz, A. Christ, O. G. Schmidt, T. Riedl, A. Hangleiter; Appl. Phys. Lett. 83, 887 (2003)

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