Solutions for Carbon Doping

- **Low Temperature Gas Source for Carbon Doping**
  - Introduces gas without thermal pre-cracking
  - CBr_4 source for C doping in III-Vs
  - More than 50 in the field
- NEW **Multi-Orifice CBr_4 Gas Flow Control System**
  - Efficient, controllable means of introducing CBr_4 gas into UHV environment
  - Optional independent plumbing system converts H_2 gas to atomic hydrogen to facilitate substrate cleaning

Description

The Veeco Low Temperature Gas Source provides a low-cost means to introduce a source gas without thermal pre-cracking. The source features a large conductance tube for fast gas switching and a diffuser end plate for good growth uniformity. With advanced flux modeling, the end plate hole pattern is customized to the specific MBE system for optimal performance. A band heater, external to vacuum, heats the source to a temperature range (<200°C) sufficient to prevent condensation of gas in the tube, yet not high enough to promote cracking.

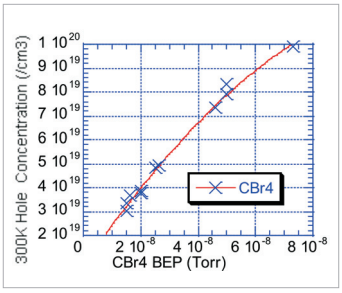
To make efficient use of the source ports on an MBE system, this source may be combined on a single mounting flange with the Atomic Hydrogen Source, or a conical Dopant Source. For these combination sources, the gas injector does not include a separate band heater, but rather is heated by the source or hydrogen-cracking filament.

The Veeco Low Temperature Gas Source is recommended for use with Veeco's Multi-Orifice CBr_4 Gas Flow Control System for best performance. The system allows control of the introduction of CBr_4 gas into an ultra-high vacuum (UHV) environment, utilizing CBr_4 gas as a carbon dopant source. The system regulates the CBr_4 gas using closed-loop pressure control and a series of pneumatically operated on/off valves to regulate the gas. It also incorporates interlocks to prevent equipment damage and ensure optimal vacuum system performance.

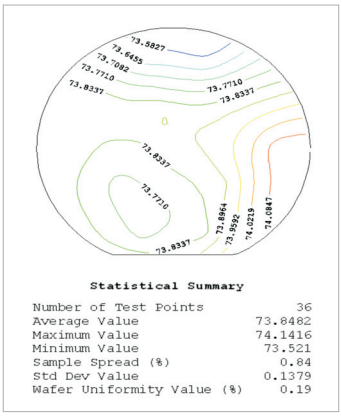
The Veeco CBr_4 system includes two modes for selecting system states: LOCAL mode, using the touch screen on the CBr_4 controller; or REMOTE, using Molly® Growth Control Software or other process control computer software using Modbus TCP. REMOTE state on automated systems is only available with version ECS1 Molly Software.

Performance and Benefits

Carbon is often a preferable p-type dopant, used to replace beryllium or zinc in GaAs materials, due to its low diffusion coefficient. While solid carbon sources have been found to provide useful doping into the mid $10^{19}cm^{-3}$ range, our gas source is much more versatile and reliable. It delivers CBr_4 gas without exhibiting long-term memory effects, and is highly efficient—permitting doping densities into the $10^{20}cm^{-3}$ range with no evidence of any bromine incorporation. The Veeco Multi-Orifice CBr_4 Gas Flow Control System simplifies the control of the gas through multiple, selectable valved orifices and gas pressure. CBr_4 is an excellent choice as it is cracked at the heated substrate surface, eliminating the need for any thermal pre-cracking in the gas injector.



Carbon doping up to 1 x 10^{20} cm^{-3} is achieved reproducibly in InGaAs. The CBr_4 source gas is delivered using the Low Temperature Gas Source and the Veeco Gas Handling System. Data courtesy of Intelligent Epitaxy Technology.



Excellent carbon doping uniformity (< 0.2%) in InGaAs is demonstrated by resistivity measurements across a 4" wafer grown in a 4x4" multi-wafer MBE system using the Low Temperature Gas Source for CBr_4. This sample has a film thickness and hole mobility of 350nm and $60cm^2/Vs$, respectively. Data courtesy of Intelligent Epitaxy Technology.

Gas Source Specifications

MBE System	Available for use on all R&D and production MBE systems
Recommended gas source	NH_3, CBr_4, high vapor pressure organics, or any other gas which does not require thermal pre-cracking of deposition
Minimum mounting flange size	2.75"/70mm (dependent on combination of sources)
In-vacuum length	Minimum 12.5"/318mm, Maximum 20.35"/517mm
In-vacuum O.D.	Minimum 1"/25mm (dependent on combination of sources)
External Dimensions	Contact Veeco
Filament Type	External band heater
Thermocouple	
Standard	One non-contacting Type K (Chromel/Alumel)
Combination source with dopant source	One Type C (w/Re 5/26%) band
Combination source with atomic hydrogen source	Optional Type C (W-Re 5/26%) non-contacting
Heating	
Standard	External band heater
Combination Source	Resistively heated filament installed on Dopant or Atomic Hydrogen Source
Gas Inlet	Varies with source. Contact Veeco.
Typical Operating Temperature	30-200°C
Maximum Outgassing Temperature	200°C
Power Supply	One Veeco Auto-Ranging DC Power Module is recommended

CBr_4 Gas Flow Control System Specifications

Physical Dimensions	
Height	43.25"/1099mm
Width	28.16"/715mm
Length	34.5"/622mm
Source Gas	• CBr_4 only for main plumbing in upper side cabinet • H_2 only for optional separate circuit
N_2 Requirements	• 5psi N_2 input pressure from facility • Ultra-high-purity N_2 required for system startup, shutdown, and bottle-replacement procedures
Compressed Air Requirements	60-80psi input pressure from facility
Voltage	208-250VAC, single phase
AC Input Frequency	50-60Hz
Communication Modes	LOCAL (via CBr_4 controller touch screen) or REMOTE (via the process control computer)
Communications Protocol (for REMOTE communication mode)	Modbus TCP/IP over Ethernet

Veeco

Solutions for a nanoscale world.™

Compound Semiconductor • MBE Operations
4900 Constellation Drive, St. Paul, MN 55127 USA
Phone: (651) 482-0800, Fax: (651) 482-0600
www.veeco.com/mbe