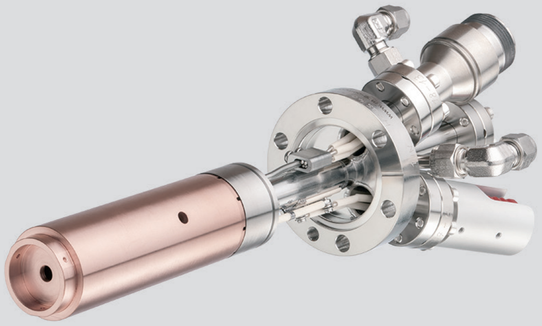
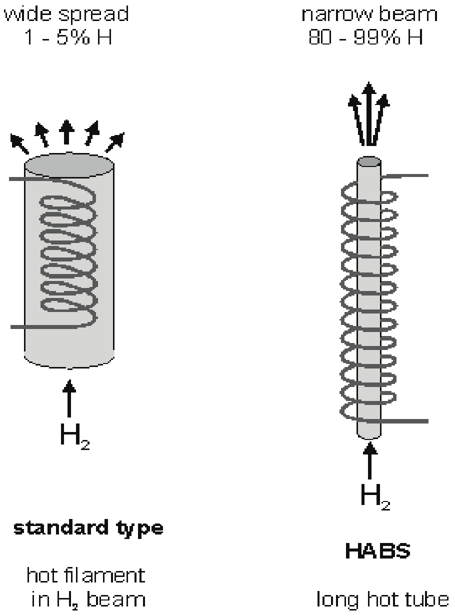
MBE
KOMPONENTEN | DR. EBERL

HYDROGEN ATOM BEAM SOURCE HABS

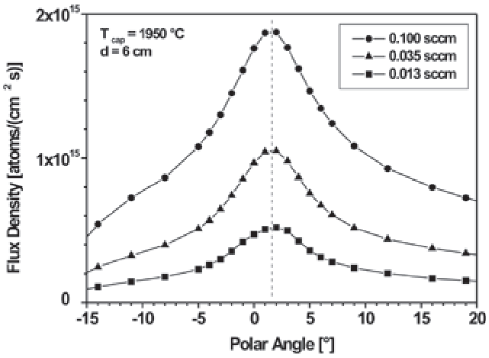
- H_2 dissociation typically 80 to 98%, depending on operation conditions
- Atomic H-flux density up to 10^{16}/cm^{2}s
- No high-energy particles and ions
- Low power consumption (P < 200 W)
- Integrated water cooling, low thermal load on other experimental equipment



HABS 40 on DN40CF (O.D. 2.75") flange



Comparison of cracking efficiency and principles of standard type hydrogen sources vs. HABS source



Angular distribution of the H-atom flux density at a sample positioned 6cm in front of the capillary, adjusted by a mass flow controller

The Hydrogen Atom Beam Source HABS is a thermal gas cracker that produces an absolutely ion-free hydrogen gas beam, thus avoiding ion induced damage to the substrate.

The source was developed and characterized by Dr. Karl G. Tschersich, Institute of Bio- and Nanosystems (formerly Institute of Thin Films and Interfaces) at Juelich Research Centre. MBE-Komponenten manufactures and markets the HABS under licence of Forschungszentrum Jülich GmbH.

The centerpiece of the HABS is a long tungsten capillary heated by a DC heated surrounding W-filament. Operation temperatures up to 2100°C provide an efficient thermal cracking of H_2 molecules within the capillary. The high purity W-tube is the only part of the HABS with direct contact to the hydrogen gas. It ejects a narrow angle distributed gas beam, due to the long heated area within the W-tube.

The HABS allows high flux rates at the sample position while keeping the H_2 background pressure of the chamber low, compared to hot filament H-cells and locally e-beam heated tungsten tube H-cells.

Despite the high temperatures needed for thermal gas cracking, the thermal load on the chamber is negligible, due to the integrated water cooling.

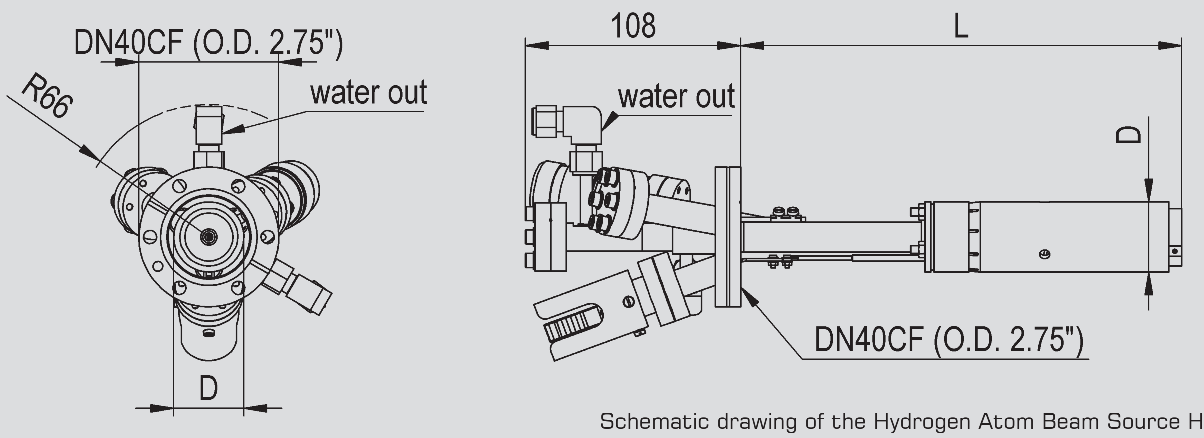
Applications

The use of a long, slender tungsten capillary results in a narrow angle distribution of the atomic hydrogen beam (FWHM: 10-20°), which makes the HABS ideally suited for medium and low gas flux applications (up to 1 sccm) on smaller sample sizes or longer substrate distances. For 1 inch substrates, for example, excellent performance is achieved in a typical working distance of 100-150mm.

- Low Temperature Surface Cleaning of InP and GaAs
  In MBE the cleaning of substrate surfaces is very important to reach high quality epitaxial films. GaAs or InP substrate wafers can be cleaned while being irradiated with atomic H. Carbon contamination is removed at substrate temperatures as low as about 200°C and oxygen at temperatures of about 400°C.
- Si Substrate Preparation / GaAs on Si
  Atomic hydrogen is used for in-situ cleaning of Si substrates, leading to significant reductions in surface contamination. Atomic hydrogen irradiation has also been used during growth of GaAs on Si substrates to achieve lower defect densities.
- Promotion of 2D Growth of GaAs
  Improved properties of MBE grown GaAs are reported after atomic hydrogen enhanced growth, compared with standard grown GaAs.
- Selective Epitaxial Growth in MBE and GS MBE
  Another feature of atomic hydrogen enhanced MBE growth is selective epitaxial growth. This technique allows local selective deposition of MBE related materials onto a prepared substrate.

Technical Data

Mounting flange	DN40CF (O.D.2.75“)
Dimensions in vacuum	L=190-400 mm, D=36 mm
Filament type	Tungsten filament
Gas line	filament heated W capillary
Thermocouple	W5%Re/W26%Re (type C)
Bakeout temperature	max. 250°C
Operating temperature	up to 2100°C
Cooling	integrated water cooling
Option	integrated shutter (S)



Schematic drawing of the Hydrogen Atom Beam Source HABS
(Drawing shows HABS 40)