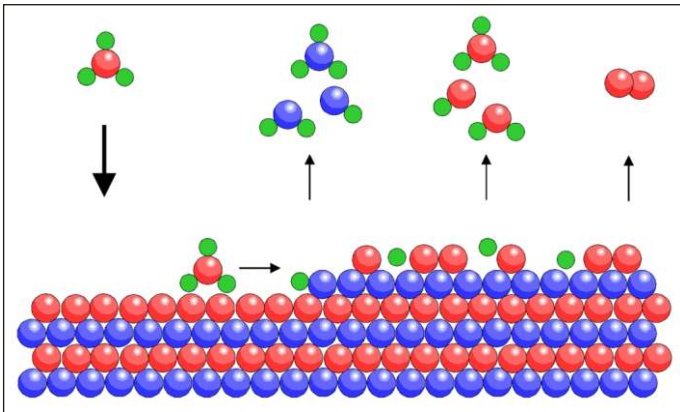


## AsBr<sub>3</sub> IN-SITU ETCHING SYSTEM ISES



AsBr<sub>3</sub> etching mechanism

The In-situ Etching System - ISES - is a fully UHV and MBE compatible gas source for high vapour pressure materials like AsBr<sub>3</sub>, used for in-situ etching applications.

AsBr<sub>3</sub> in-situ etching provides atomic layer precise manipulation of thin films and nanostructures. The use of AsBr<sub>3</sub> as the etchant species without any carrier gas guarantees full compatibility to all standard III-V-MBE systems. Due to the very small amount of AsBr<sub>3</sub> which is injected into the MBE system, no extra installations (extra pumps etc) are needed and no significant interaction, corrosion, etc of the MBE system is observed even after several years of operation.

The in-situ etching system is a stand-alone system which requires external supply of compressed air, clean N<sub>2</sub>, cooling water and waste air as well as electrical power. Only a free DN40 CF (O.D. 2.75") flange for the gas injector unit is needed to connect to the MBE system.

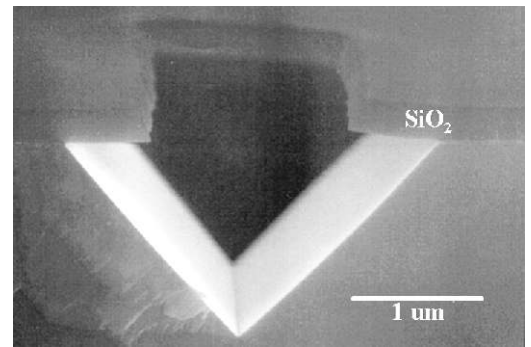
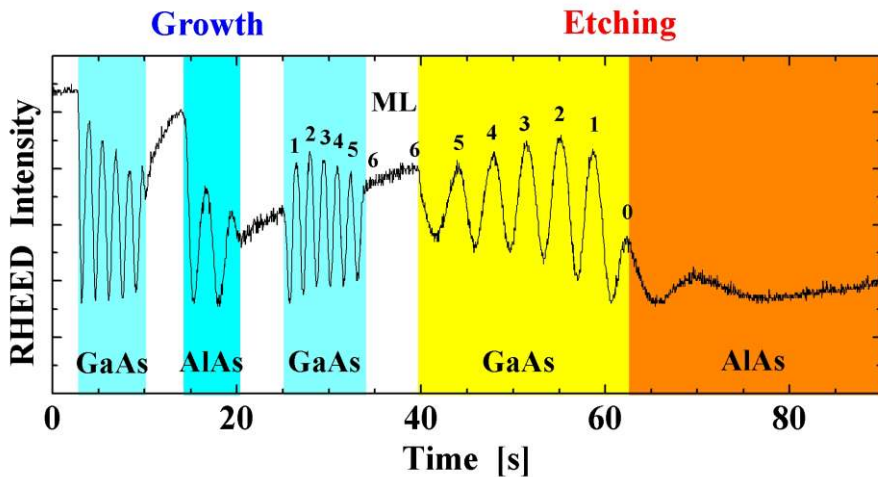
The solid state (or liquid) etchant material is stored and evaporated in a gas cabinet. The gas cabinet also includes a mass flow controller (MFC) for vapour flow control and an own UHV system to provide a continuous flow and for evacuating the gas system to achieve high purity operation conditions. An exhaust filter and an integrated gas alert system guarantees a safe and non-polluting operation. All equipment needed for operation is mounted into the gas cabinet and therefore it represents a compact and easy handling tool. Most electronic controllers have integrated standard computer interfaces for fully automated operation.

Optionally the ISES system can be extended to a second material source as well as to a second gas injector unit.

- AsBr<sub>3</sub> atomic precise etching
- No carrier gas required
- Fully UHV and MBE compatible
- No memory effect on MBE growth properties
- Free standing system
- Integrated safety management
- Computer controlled operation
- Second material optional



Gas cabinet of the AsBr<sub>3</sub> in-situ etching system ISES



SEM image of an in-situ etched patterned GaAs sample [3]

AsBr<sub>3</sub> in-situ etching allows atomic precise layer by layer etching inverse to the layer by layer MBE growth.

The figure above shows RHEED oscillations of a typical growth-etching sequence indicating the precise removal of 6 monolayers of GaAs which have been deposited earlier. Due to the lower etching rate of AlAs the oscillations slow down after the removal of the GaAs and when the AlAs layers are reached.

Material selectivity is a typical property of AsBr<sub>3</sub> etching of the group III-metal atoms. Indium shows the highest etching rate while Aluminium shows the lowest rate of the group III atoms In, Ga and Al.

An application is for example the growth of etch-stop layers for precise etching depth control or the modification of self assembled InAs or InGaAs quantum dots. [4]

Another feature is the crystallographic selectivity which allows the preparation of atomically planar facets.

The forming of a very sharp V-groove after in-situ etching of a masked GaAs sample is shown in the picture on the right. Using suitable processing conditions AsBr<sub>3</sub> underetches the SiO<sub>2</sub> mask and forms smooth crystallographic facets and a narrow, linear ridge which allows the preparation of wire structures in an in-situ regrowth process. [1,3]

## Technical Data

Etching Material	AsBr <sub>3</sub> , optional: SbBr <sub>3</sub> , PBr <sub>3</sub> etc.
Bakeout temperature	gas injector: max. 300°C; gas supply tubing: max 100°C
Operating temperature	AsBr <sub>3</sub> : 30°C; gas injector: 150°C; gas supply tubing: 60°C
Dimensions (h x w x d)	gas cabinet: 198 x 124 x 55 cm
Requirements	high purity N <sub>2</sub> , compressed air, cooling water, waste air, electrical power

## Literature

- [1] In-situ etching and regrowth in III-V molecular beam epitaxy for future nanotechnology  
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- [3] Atomic Layer In-situ Etching and MBE-Regrowth  
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- [4] Size and shape modification of self assembled InAs quantum dots and stacked layers by in-situ etching  
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