

Anhydrous Hydrazine Gas Delivery for Atomic Scale Fabrication

Low temperature, high reactivity nitride source for ALD and MOCVD processes

RASIRC® BRUTE® Hydrazine delivers anhydrous hydrazine (N₂H₄) gas into atomic layer deposition (ALD) processes in a repeatable method. BRUTE® Hydrazine includes a vaporizer pre-loaded with hydrazine and a proprietary organic solvent.

By loading anhydrous hydrazine dissolved in proprietary solvent, it allows:

- Lower flammability (Flash Point = 47°C)
- Lower toxicity
- Stable anhydrous, high purity solution
- For thorough example view [Table 1](#)

BRUTE® Hydrazine can be used for a variety of metal nitride deposition processes at temperatures below 400°C:

- Precursor for TiN gate stack and other metal nitride applications
- Sidewall spacer/etch stop (SiN) between metals and silicon or dielectric materials
- Double patterning involving SiO₂ and SiN
- SiGe passivation layer
- Metal nitride deposition (TaN WN)
- Enables uniform nitride deposition for titanium and early transition metals at low temperatures
- Can be used as an atomic hydrogen source
- TiN, Ru, Cu, and Co can be cleaned and reduced as an initiation step for passivation and ALD

RASIRC® BRUTE® Hydrazine Benefits

- Higher reactivity than NH₃ enables lower temperature ALD applications (200-400°C)
- Penetrates high aspect ratio structures to achieve uniform films
- Lower temperature allows for gate-first processing
- Replacement for N₂ plasmas for uniform SiN spacers and etch stops
- Proprietary delivery process, ensuring higher purity
- Only semiconductor grade hydrazine on the market
- Higher growth rate than ammonia (NH₃)
- Vaporizer orders available for HVM 1.2L ([Figure 1](#)) or R&D 250ml ampoules
- Water contamination as low as 10ppb

Background

Plasma and ammonia have been used for growing nitride films in the past. These methods work poorly with next generation materials that require lower thermal budgets and feature high aspect ratio structures. Plasma cannot uniformly coat the side walls of high aspect ratio structures and can cause surface damage. Ammonia has limited reactivity at the low process temperatures required for new materials and metal-organic precursors.

Hydrazine has been proposed as a nitride source, but residual water in commercially available hydrazine leads to imperfect films containing oxygen. BRUTE® Hydrazine is the only semiconductor grade hydrazine on the market, delivering a high concentration of hydrazine with minimal water. With BRUTE® Hydrazine, thin nitride films can be effectively created at lower temperatures and higher purity in comparison to ammonia.

How it Works

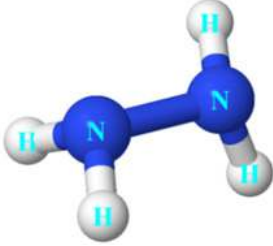
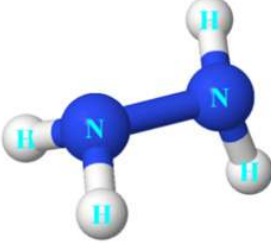
BRUTE® Hydrazine provides a stable, reliable flow of anhydrous hydrazine gas from a liquid source in a sealed vaporizer. The liquid source combines anhydrous hydrazine and a proprietary solvent that acts as a stabilizer.

The BRUTE® Hydrazine vaporizer converts source liquid hydrazine to gas while leaving behind the non-volatile solvent. Hydrazine vaporizes into the headspace of the vaporizer. The resulting hydrazine gas is swept to process via vacuum draw or by an optional carrier gas that follows through the headspace.



Figure 1: BHV 1.2L Ampoule

Table 1:
BRUTE® Hydrazine Physical & Chemical Properties Compared to Commercial Hydrazine

	Hydrazine	BRUTE® Hydrazine
Gas Molecule		
Color	colorless	colorless
Odor	ammonia, amine odor	ammonia, amine odor
pH	strong base	16.3, strong base
Melting/Freezing Point	-2°C	-25°C
Boiling Point	114°C	116.2°C
Flash Point (with ignition source)	38°C	46.7°C
Flammability Limit	1.8 – 100vol%	3.3 – 51vol% (@125°C)
Relative Density (g/cm³)	1.0036 (@25°C)	1.05 (@20°C)
Vapor Pressure	16 torr (@25°C)	14 torr (@20°C)
Water Solubility	miscible	miscible
Auto Ignition Temperature	270°C on glass	217°C on glass
Decomposition Temperature	N/D	150.3°C on SS
TLV (ACGIH TWA)	0.01 ppm	0.01 ppm
NFPA Rating	Health — 4 Flammability — 4 Instability — 3	Health — 3 Flammability — 2 Instability — 1

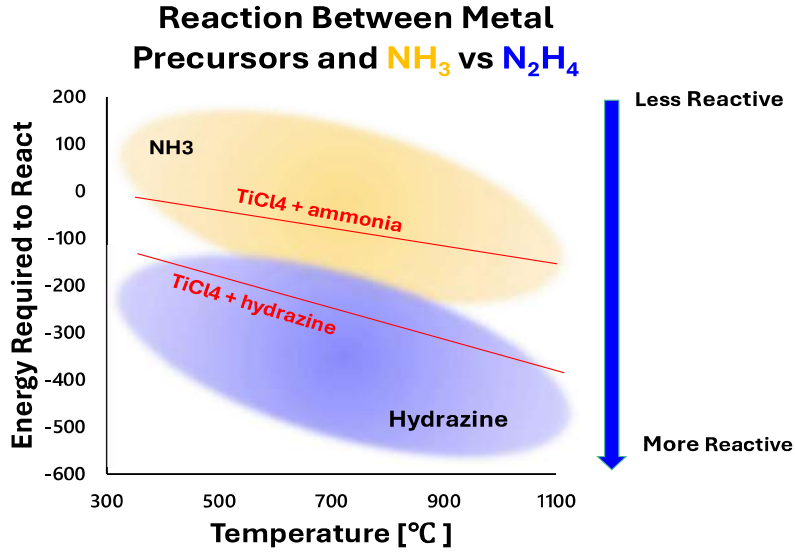


Figure 2: Hydrazine has a lower activation energy than ammonia, making it more viable for low temperature ALD reactions.

Bond Dissociation Energy

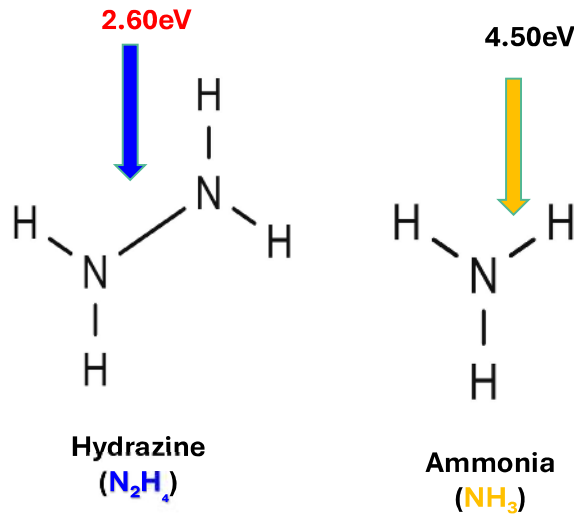


Figure 3: The low dissociation energy of hydrazine's nitrogen-nitrogen makes it more reactive and provides more amine groups than ammonia.

Table 2: BRUTE® Hydrazine Product Grade Breakdown

BRUTE® Grade	Maximum Moisture Content*	Certification
BRUTE® Hydrazine 7.0	Less than 100 ppb	Each vessel verified for compliance
BRUTE® Hydrazine 8.0	Less than 10 ppb	Each vessel verified for compliance

*[Contact RASIRC®](#) for testing parameters

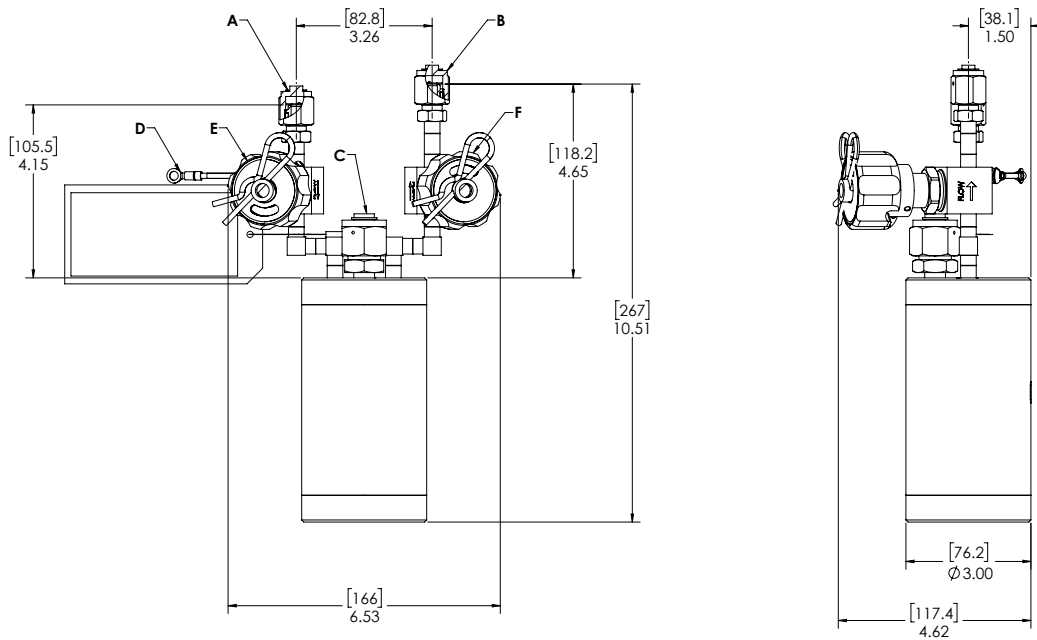


Figure 4: BRUTE® Hydrazine 250 Vaporizer. Based on RASIRC® Drawing #203403. Vaporizer Part #100834. (mm denoted in brackets; corresponding inches denoted without brackets)

Table 3: Vaporizer Connections (250)

	Description	Size/Type
A	Inert Gas Inlet	1/4" Male VCR*
B	Process Gas Outlet	1/4" Male VCR
C	Fill Port	DO NOT USE
D	Grounding Cable	18" length of wire with M5 terminal ring (included)
E	Inlet Valve	Manual Lock Out / Tag Out Valve
F	Outlet Valve	Manual Lock Out / Tag Out Valve

*VCR is a registered trademark of Swagelok

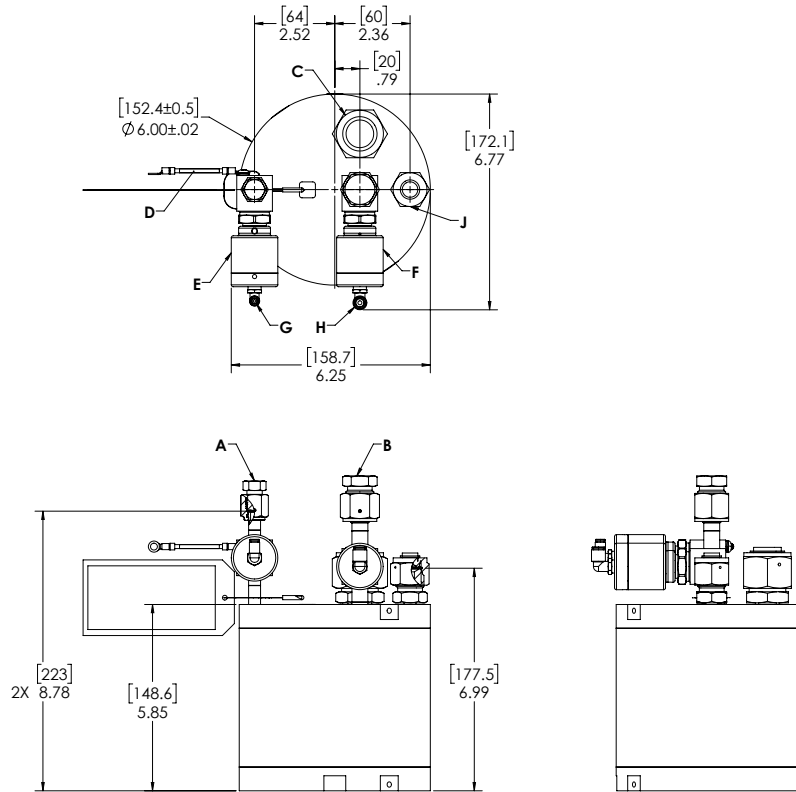


Figure 5: BRUTE® Hydrazine 1000 Vaporizer. Based on RASIRC® Drawing #203690. Vaporizer Part #100857.
(mm denoted in brackets; corresponding inches denoted without brackets)

Table 4: Vaporizer Connections (1000)

	Description	Size/Type
A	Inert Gas Inlet	1/4" Female VCR
B	Process Gas Outlet	1/2" Female VCR
C	Fill Port	DO NOT USE
D	Grounding Cable	18" length of wire with M5 terminal ring (included with vaporizer)
E	Inlet Valve	Pneumatic Valve (70 to 110 psig actuation pressure)
F	Outlet Valve	Pneumatic Valve (70 to 110 psig actuation pressure)
G	Inlet Pneumatic Input	5/32" Push Connect
H	Outlet Pneumatic Input	1/4" Push Connect

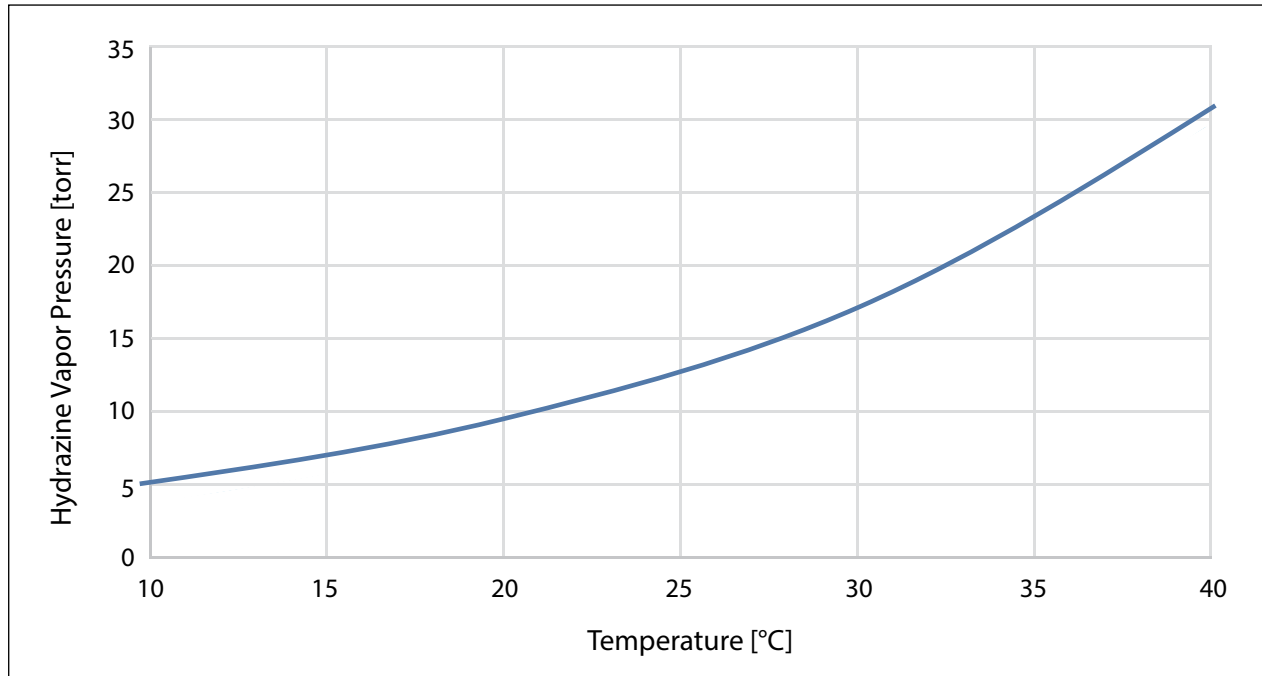


Figure 6: Theoretical vapor pressure curve of BRUTE® Hydrazine.

Table 5: Facilities Specifications

Operating Conditions	<ul style="list-style-type: none"> • Temperature: 10-40°C (Heaters must have secondary interlock) • Max Pressure: 1500 torr
Carrier Gas	<ul style="list-style-type: none"> • 250 Vaporizer: 0-500 sccm (user supplied MFC) • 1000 Vaporizer: 0-5000 sccm (user supplied MFC) • Filtered to 0.003 µm • Purified to <1 ppb contaminants • Nitrogen or inert gas (NO OXYGEN)
Vapor Pressure (See Figure 6 for graph)	<ul style="list-style-type: none"> • 31 torr at 40°C • 13 torr at 25°C
Tools & Supplies Required (250g)	<ul style="list-style-type: none"> • PPE (see SDS) • (2) 1/4" SS VCR gaskets no silver plating (Swagelok PN: SS-4-VCR-2-VS) • 3/4" and 5/8" wrenches
Tools & Supplies Required (1000g)	<ul style="list-style-type: none"> • PPE (see SDS) • (1) 1/4" SS VCR gasket no silver plating (Swagelok PN: SS-4-VCR-2-VS) • (1) 1/2" SS VCR gasket no silver plating (Swagelok PN: SS-8-VCR-2-VS) • 3/4", 5/8", 15/16", and 1 1/16" wrenches

Table 6: BRUTE® Hydrazine Chemistry

Name	Mass Loading	Chemistry Part Number	Vaporizer Part Number
BRUTE® Hydrazine 7.0*	1000g	110166-1000g7.0	100857
BRUTE® Hydrazine 7.0	250g	110166-250g7.0	100834
BRUTE® Hydrazine 8.0*	1000g	110166-1000g8.0	100857
BRUTE® Hydrazine 8.0	250g	110166-250g8.0	100834

*[Contact RASIRC®](#) to fill OEM specific 5-valve vessels

How to Order

To place an order for **BRUTE® Hydrazine**:

1. Use [Table 6](#) to identify the desired chemistry weight (g) and vaporizer.
2. Contact RASIRC® at sales@rasirc.com

About RASIRC®

RASIRC® products generate and deliver water vapor, hydrogen peroxide, and hydrogen gas to enable critical processes.

