Hydrogen Peroxide Gas for Thin Film Processing

Increase surface hydroxylation, lower process temperatures & increase choice in precursors

BRUTE Peroxide 2 Series is the next generation product from RASIRC to deliver concentrated hydrogen peroxide (H_2O_2) gas for Atomic Layer Deposition (ALD), Area Selective Deposition (ASD), and other processes that require controlled delivery of H_2O_2 gas with minimal water. This improved version of BRUTE Peroxide delivers gas from a solid source and has superior output and longer shelf life than previous BRUTE Peroxides. Design advantages include improved output stability, concentration, purity, and safety. H_2O_2 molecules pre-loaded onto the proprietary solid sorbent in an engineered vaporizer that is designed specifically for the stable storage and delivery of H_2O_2 gas for high purity applications. BRUTE Peroxide 2 Series simplifies having to store or handle high concetration liquid peroxide.

Background

Oxidants such as oxygen, water, oxygen plasma, and ozone have all been used for cleaning, stripping, hydroxylation, and oxidation in thin film processes. However, with shrinking thermal budgets, oxygen, plasma, and water are not as effective as they once were. Ozone and plasma can be difficult to control, can cause surface and subsurface damage, and generate non-uniformities in High Aspect Ratio (HAR) structures.

With BRUTE Peroxide 2 Series, H_2O_2 is now a superior alternative to these older methods. H_2O_2 has a rapid and straightforward reaction pathway. BRUTE Peroxide overcomes historical concentration control issues of water in the H_2O_2 source.

Typical water/H_2O_2 solutions produce relatively low H_2O_2 gas concentrations. Water has significantly higher vapor pressure compared to H_2O_2. This leads to a high concentration of water in the headspace, which is ultimately delivered to the chamber.

Frequently overestimated, the H_2O_2 gas concentration in the headspace above a 30 wt% H_2O_2 solution is only 25 ppm, not 30%. The molar ratio of H_2O_2 to water is 1:181 at 0°C, 760 torr.

Prior to BRUTE Peroxide commercialization, the majority of technical publications frequently concluded that there was minimal process difference between H_2O_2 and water. However, the studies failed to deliver enough H_2O_2 to demonstrate the superiority of H_2O_2 to water in the process.

BRUTE Peroxide Benefits

- Provides stable delivery of H_2O_2 gas with minimal water.
- It is not a nebulizer, which releases liquid droplets of H_2O_2/ H_2O and leads to non-uniformity, spotting, and particulates.
- Allows for differentiation between H_2O_2 and water vapor in process reactions.
- Alternative to water, ozone, or oxygen plasma.
- Improves compatibility with metal surfaces—less aggressive oxidant than ozone or Oxygen Plasma.
- H_2O_2 is self limiting, once it reacts with all open active sites on the surface, the reaction ends.
- Enables ambient delivery of H_2O_2 gas without the need for additional heating related decomposition.
- Reacts faster and at lower temperatures than water.
- Superior surface density hydroxylation with minimal subsurface oxidation.
- Superior penetration into 3D and HAR microstructures compared to water.
- Allows for high concentration H_2O_2 delivery into vacuum and low-pressure applications.
- Increases interface hydroxyl density on substrates such as Si, Ge, and SiO_2.
- Proprietary delivery process, ensuring higher purity.
- Overcomes Raoult's Law to provide constant mass flow rate as source is consumed.

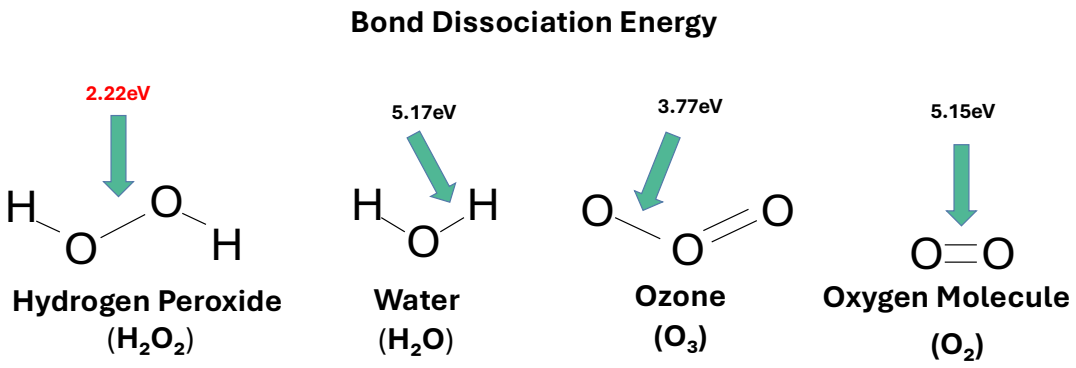
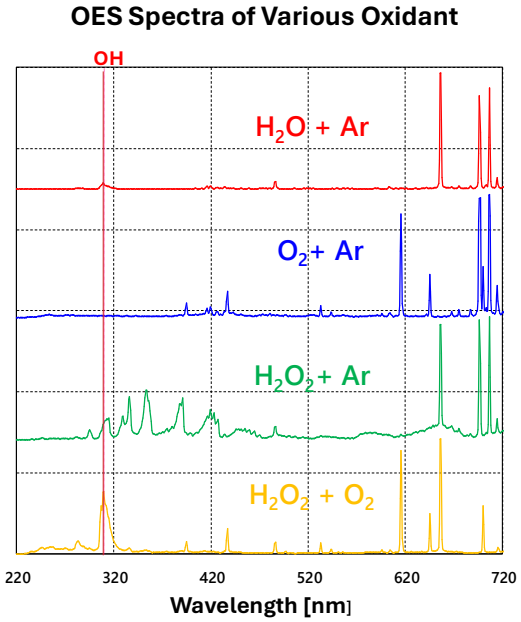


Figure 1: The low dissociation energy of hydrogen peroxide's oxygen-oxygen bond makes H_2O_2 more reactive than conventional oxidants.



Relative Oxidation Power (Cl=1.0)	
Flourine	2.23
Hydroxyl Radical	2.06
Atomic Oxygen (singlet)	1.78
Ozone	1.52
Hydrogen Peroxide	1.31
Perhydroxyl Radical	1.25
Chlorine Dioxide	1.15
Chlorine	1.00
Bromine	0.80
Iodine	0.54
Oxygen	0.29

Stronger

Figure 2: Hydrogen peroxide has a hydroxyl density 10x higher than water plasma, leading to easier access to hydroxyl radicals that have a higher oxidation potential than atomic oxygen.

Table 1: P/N: 100955 Ampoule Index

Index	Description	Size/Type
A	Insert Gas Inlet	1/4" Male VCR*
B	Process Gas Outlet	1/4" Male VCR
C	Vent Relief Port	9/16-18 UNF
D	Grounding Cable Assembly	18" length of wire with MF Terminal Ring (included with vaporizer) Part #201990

***VCR is registered trademark of Swagelok**

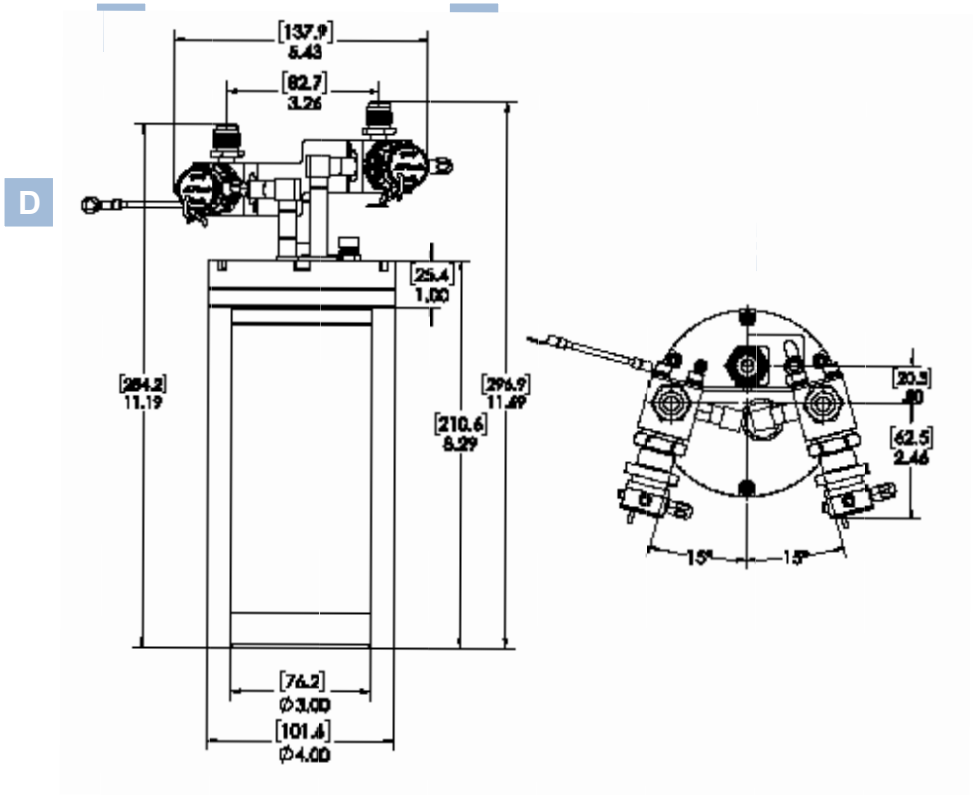


Figure 3: P/N 100955 Ampoule Design, 235 Gram Fill

Table 2: BRUTE Peroxide vs. H_2O_2/H_2O Solutions

Solution Concentration (weight percent peroxide)	H_2O_2 Concentration (ppm)	H_2O Concentration (ppm)
30	203*	24,131*
50	533*	17,143*
70	1,142*	9,241*
BRUTE Peroxide 2 Series	2,248**	1,128**

***Theoretical values based upon 25C and 760 torr per Raoult's Law.**
****Measured at 25C and 760 torr carrier gas flowrate of 1000 SCCM.**

Table 3: Specifications

Operating Conditions	• Temperature: 15-40°C • Pressure Range: 0-1520 torr
Carrier Gas Requirements (if used)	• 0-2000 sccm (user controlled MFC) STP: 0°C and 760 torr • Filtered to 0.003 µm • Purified to <1 ppb contaminates • CDA, Oxygen, Nitrogen, or inert gas
Vaporizer Output	• ≥10mg/min at 20C and 100 torr with 500 sccm carrier gas
Tools & Supplies Required	• PPE (see SDS for BRUTE® Peroxide RASIRC® P/N 900966) • (2) 1/4" SS VCR gaskets no silver plating (Swagelok PN: SS-4-VCR-2-VS) • 3/4" and 5/8" wrenches
Shelf Life	• 12 weeks at 25°C • 12 months if stored at 0-10°C
Vent Relief Cracking Pressure	• Vessel will relieve pressure when above 25.0 psig

Table 4: BRUTE Peroxide Chemistry

Name	Mass Loading	Part Number
BRUTE Peroxide 450 Form Vessel	235g	110232-235G
OEM Form Vessel	400-500g	Contact RASIRC

How to Order

To place an order for **BRUTE Peroxide**:

1. Use Table 4 to identify the part number for the desired chemistry weight (g)
2. Contact RASIRC at sales@rasirc.com

About RASIRC

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