



FOR IMMEDIATE RELEASE

## **Hydrogen Peroxide Gas for Next Generation Semiconductor Processes**

***RASIRC BRUTE™ Peroxide delivers water-free H<sub>2</sub>O<sub>2</sub> to enable new ALD reactions***

San Diego, Calif – July 9, 2015 – Today, RASIRC announced the general availability of BRUTE Peroxide, anhydrous hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) for semiconductor fabrication processes such as atomic layer deposition (ALD) and atomic layer etch (ALE). BRUTE Peroxide is the only commercially available technology that can deliver up to 99.9% H<sub>2</sub>O<sub>2</sub> gas by volume. In comparison, traditional H<sub>2</sub>O<sub>2</sub> vaporizers typically deliver less than 1% H<sub>2</sub>O<sub>2</sub> gas by volume from standard H<sub>2</sub>O<sub>2</sub> liquid source. BRUTE Peroxide is the latest in a line of RASIRC products that enable the generation of gas from liquid sources to meet the demands of next generation semiconductor manufacturing.

“BRUTE Peroxide is a significant breakthrough for process engineers challenged with lower thermal budgets and equivalent oxide thickness,” said Jeffrey Spiegelman, RASIRC President and Founder. “Without water to get in the way, hydrogen peroxide gas generates denser initiation layers and is more reactive at a given temperature. Hydrogen peroxide is more effective than water and is less aggressive to metal layers than is ozone or plasma.”

### **Advantages of H<sub>2</sub>O<sub>2</sub> Gas**

Shrinking thermal budgets associated with next generation semiconductor materials and processes have created demand for a new oxidant that is more reactive than water but less aggressive than ozone and oxygen plasma. In addition, some new materials such as rare earth oxides lanthanum, gadolinium and lutetium are water sensitive and benefit from anhydrous treatment.

BRUTE Peroxide delivers anhydrous H<sub>2</sub>O<sub>2</sub> gas, enabling process engineers to differentiate water from H<sub>2</sub>O<sub>2</sub> in process reactions. High concentration H<sub>2</sub>O<sub>2</sub> gas improves wafer coverage density over water by as much as three times, leading to better

initial growth rates and fewer defects.  $\text{H}_2\text{O}_2$  gas also avoids uniformity issues that stem from using water as an oxidant, and organic contamination in ozone that can result in a high leakage current.

### **Highest Concentration $\text{H}_2\text{O}_2$ Gas**

BRUTE Peroxide includes a vaporizer pre-loaded with a proprietary non-volatile solvent that ensures safety as the  $\text{H}_2\text{O}_2$  liquid is kept below 30% by weight.  $\text{H}_2\text{O}_2$  diffuses across a proprietary membrane assembly, leaving the solvent behind. Once across the membrane,  $\text{H}_2\text{O}_2$  is swept to process by a carrier gas or pulled by vacuum conditions.  $\text{H}_2\text{O}_2$  gas by volume can be as high as 99.9%.

In contrast, bubblers typically deliver less than 1%  $\text{H}_2\text{O}_2$  gas by volume. Bubblers are subject to Raoult's Law, which causes preferential selection of water molecules from  $\text{H}_2\text{O}_2$  solution.

Vaporizers require high temperature to vaporize liquid droplets, leading to  $\text{H}_2\text{O}_2$  decomposition and micro-droplet generation. Both bubblers and vaporizers deliver high relative volumes of water along with  $\text{H}_2\text{O}_2$  gas, reducing the oxidizing benefits of  $\text{H}_2\text{O}_2$ .

### **Atomic Layer Deposition (ALD)**

Next generation semiconductor materials and architectures are more sensitive to temperature and water.  $\text{H}_2\text{O}_2$  is more reactive with metal precursors than water and less aggressive than ozone, creating an ideal surface for ALD. Test results with hafnium and aluminum precursors show that  $\text{H}_2\text{O}_2$  accelerates oxide growth compared to water and water/  $\text{H}_2\text{O}_2$  mixtures. Tests also show that  $\text{H}_2\text{O}_2$  delivers a 3x improvement in nucleation density due to its lower steric hindrance than water and ozone, and decomposes into a dense layer of hydroxyls on surfaces. For ALD cleaning applications,  $\text{H}_2\text{O}_2$  in high concentration removes carbon from Germanium surfaces without incurring damage.

“Hydrogen peroxide gas is the best choice as an oxidant for next generation semiconductors, creating denser initiation layers and reducing defects,” said Spiegelman.

“BRUTE hydrogen peroxide gas is the only choice for some materials that are water sensitive.”

### **Atomic Layer Etching (ALE)**

Next generation processes require etch precision at the atomic level where surface roughness must be minimized. Current ‘dry’ methods (HF, F<sub>2</sub>, O<sub>3</sub> and Cl<sub>2</sub> gases or plasma) form volatile byproducts and lack both precision and selectivity for new materials (SiGe, Ge, InGAs). High concentration H<sub>2</sub>O<sub>2</sub> gas gives process engineers additional options for novel precursors.

“Anhydrous hydrogen peroxide gas provides the greatest flexibility to process engineers for advanced etching applications,” said Spiegelman. “BRUTE Peroxide represents the birth of a new process technique for semiconductor fabrication.”

### **Versatility**

With BRUTE Peroxide, process engineers can precisely control their processes. BRUTE Peroxide delivers hydrogen peroxide gas into a wide range of process conditions from vacuum to atmospheric pressure. H<sub>2</sub>O<sub>2</sub> output ranges from 0.4 Torr to 6.7 Torr, depending on temperature. The maximum flow rate is 200 sccm. BRUTE Peroxide is available immediately. For details and to order, contact RASIRC.

### **About RASIRC**

RASIRC specializes in products that generate and deliver gas to fabrication processes. Each unit is a gas plant in a box—converting common liquid chemistries into safe and reliable gas for most processes. First to generate ultra-high purity (UHP) steam from de-ionized water, RASIRC technology can now also deliver hydrogen peroxide gas in controlled, repeatable concentrations. RASIRC gas delivery systems, humidifiers, closed loop humidification systems, and steam generators are critical for many applications in semiconductor, photovoltaic, pharmaceutical, medical, biological, fuel cell, and power industries. Call 858-259-1220, email [info@rasirc.com](mailto:info@rasirc.com) or visit [www.rasirc.com](http://www.rasirc.com).

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