MEIDEN

Quality connecting the next

Room temperature ALD equipment

Room-temperature ALD realized with High-purity ozone gas

Pure Ozone Solution

Pure ozone solution that only our company can realize

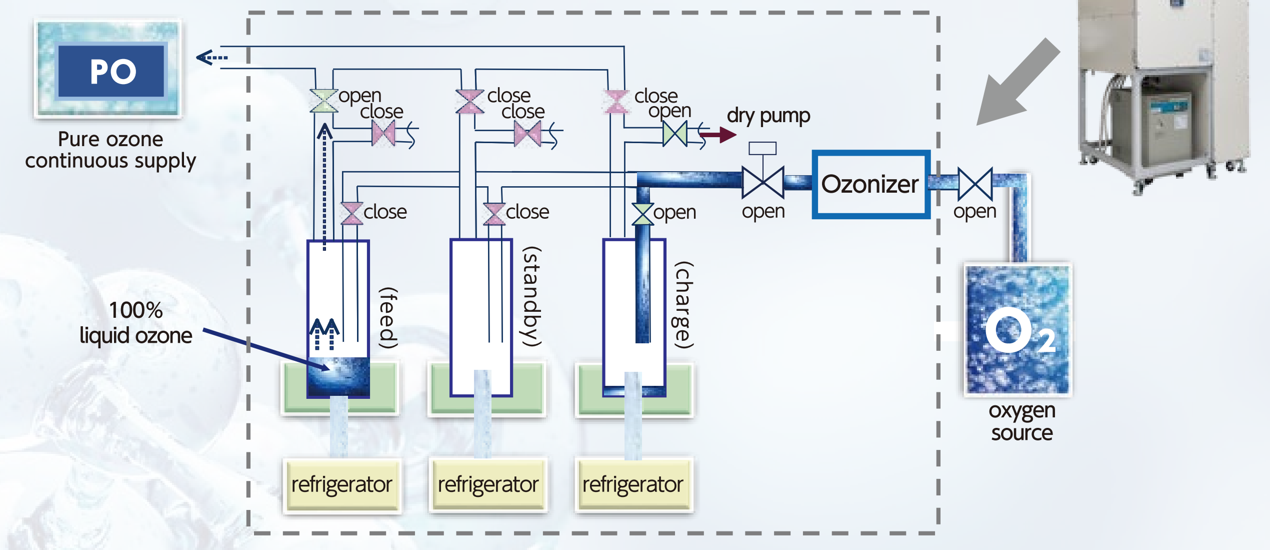
High-purity, high-concentration ozone "Pure Ozone" has been refined over many years by Meidensha Co., Ltd. We provide ozone solutions that only we can provide all over the world, such as oxidation source, film formation and reforming.

Pure Ozone Generator
Joint development with the National Institute of Advanced Industrial Science and Technology (AIST)

POG：Pure ozone generation technology

■ Ozone generated by an ozonizer is liquefied at a low temperature and only 100% liquid ozone is extracted.

■ Continuous supply of pure ozone gas with 100% concentration is possible by vaporizing only when necessary.

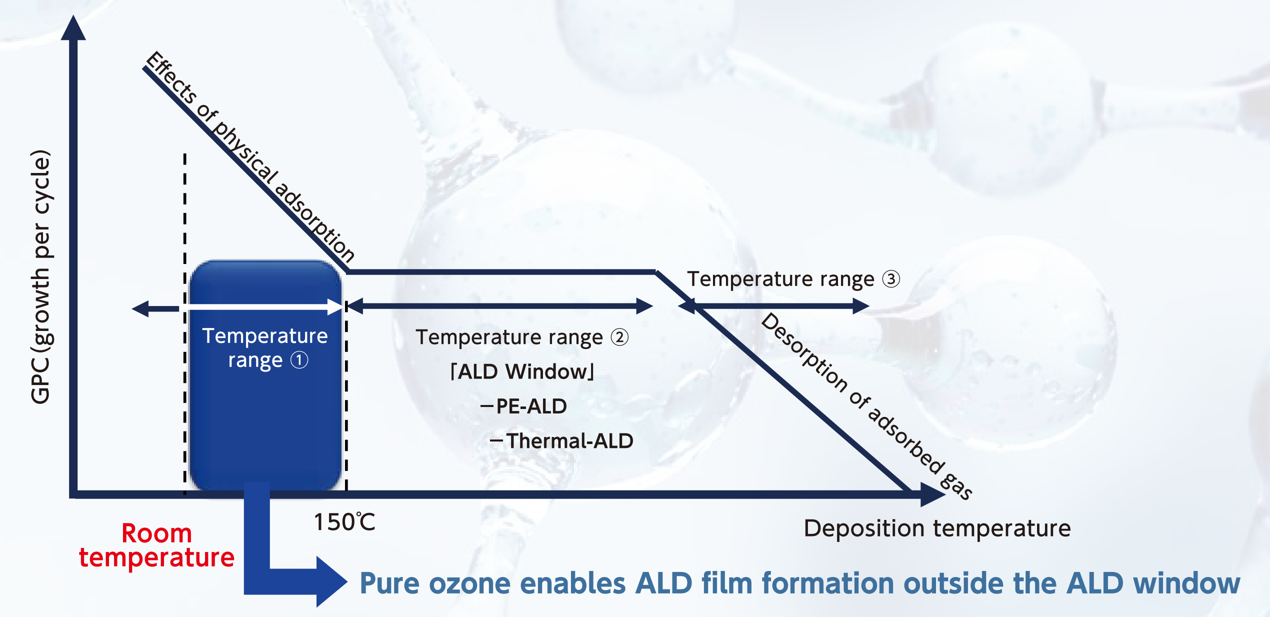


Benefits of Pure Ozone

High purity : > 80% Ozone Pressure : <10,000Pa	● **Achieves over 80% ozone utilization without ozone decomposition at low temperature(*1).** ⇒**Temperature and pressure range that enables the long lifetime of ozone.** ● Pure ozone under reduced pressure is stable and is ideal for vacuum processes.
On-demand supply	● **On-demand supply of the required amount of pure ozone.** Low-concentration ozone generated by conventional ozonizer requires a constant supply of ozone during the vacuum process.
Compatible with vacuum processes	● **ALD film formation, surface modification, ashing, and cleaning are possible at low temperature(*1).**
Pure chemical reaction	● Damage-free chemical process without any physical damage as plasma and UV. ● Ideal for substrates that require low temperatures (*1), such as low heat-resistant semiconductors, resins, and films.

*1 Low temperature: Room temperature to 150℃

Room temperature to 150℃ Pure ozone ALD



Batch production ALD system

■ PO-ALD Unit appearance

Chamber furnace
(image)

Single-wafer R&D system is also available
Please feel free to contact us for technical details,
demo samples and factory tours.

■ Features

◆**High Throughput :**
Our internally-built process recipe enables large volume of batch process.

◆**Damageless :**
Low temperature (150℃ or less) deposition with no plasma assist.

◆**Superior coverage to high aspect trench bottom :**
Realizes deposition on substrate with unique surface morphology (convex, uneven, double-sided, powder).

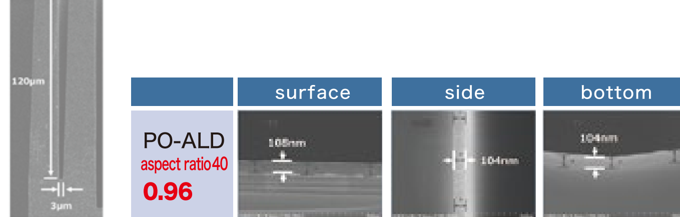
◆**Low running cost, high gas usage efficiency :**
Off-the-shelf precursors can be used with an improved gas usage efficiency.

Unit specification example	
Usage environment	15～30℃, 35～70%RH
Unit size	1,350mm(W)× 1,650mm(D)× 1,945mm(H)
Base material size	Wafer: 12 inches or less (maximum 100 sheets) Base material (glass, resin): Φ300 or 210 mm square (up to 100 sheets) Powder: Particle size 1um or more
Deposition temperature	30～150℃ (No substrate heating)

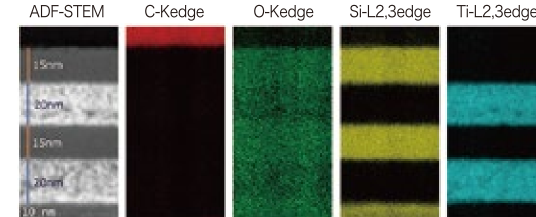
■ Specifications

Deposition specifications	SiO_2	TiO_2	Al_2O_3		HfO_2
Deposition temperature	30～150℃	50～150℃	30～150℃		50～150℃
Deposition time	30nm <2.5Hr 100nm <8Hr	30nm <7Hr 100nm <22Hr	30nm <7Hr 100nm <22Hr	30nm <5Hr 100nm <18Hr	30nm <5Hr 100nm <16Hr
Coverage for 40:1 Trench bottom	95% or more	88% or more	82% or more		95% or more
Refractive index	1.47(at 120℃)	2.23(at 120℃)	1.57(at 120℃)	1.61(at 120℃)	1.83(at 120℃)
Precursor	Orthrus	TDMAT	DMAI	TMA	TDMAHf

Example of step coverage of SiO_2 film



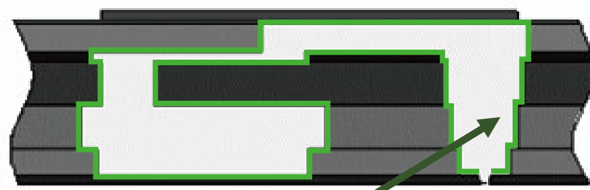
Laminated film SiO_2/TiO_2 cross-sectional structure



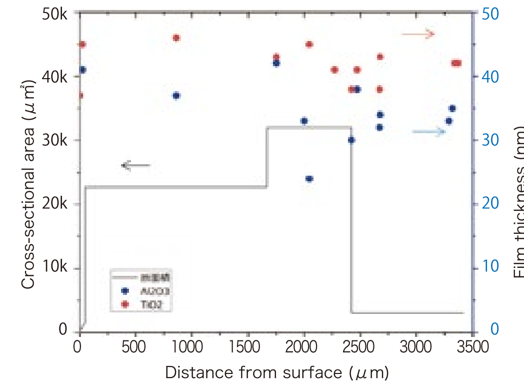
Room temperature to 150℃ Pure ozone ALD

PO ALD example "High trench" ··························· Deposition to microfluidic channel

Image of fluid flow path of porous devices with complex-shaped flow path.



"Strong oxidizing ability" and "long lifetime" of pure ozone help achieve high step coverage.



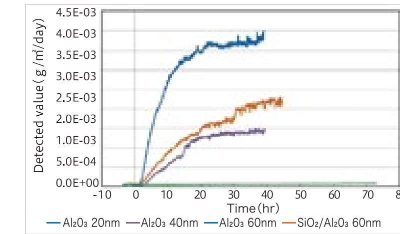
Result of film deposition on a microfluidic channel
This is not the film formation result for the channel image shown in the left figure.

PO ALD example "High gas blocking capability" ··························· Display, FPD

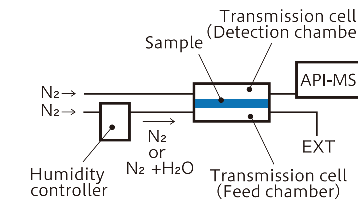
Water Vapor Transmission Rate results

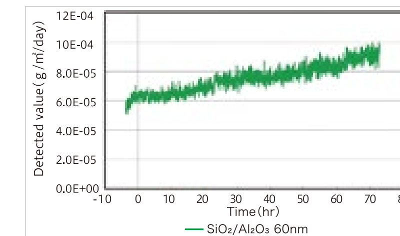
unit : g/㎡/day

Sample name	Water vapor barrier
Al_2O_3 20nm	3.6E-03
Al_2O_3 40nm	2.1E-03
Al_2O_3 60nm	1.4E-03
SiO_2/Al_2O_3 Lamination 60nm	2.8E-05



API-MS (10^{-6}～10^{-3}g /㎡/day)





By applying a laminated oxide film structure, higher water vapor barrier property has been obtained.

[Must see] POG can be used as an oxidation source for your ALD equipment

■ Advantages of introducing POG

◆**[Realization of low running cost]**
Low-concentration ozone generated by an ozonizer requires constant ozone bypass flow, which makes the process inefficient.
POG supplies ozone gas when needed without unnecessary loss by keeping the gas charged in the supply piping with a constant pressure.

◆**[Room temperature film formation (150℃ or less)]**
Ideal for substrates that require low temperatures, such as low heat-resistant semiconductors, resins, and films.

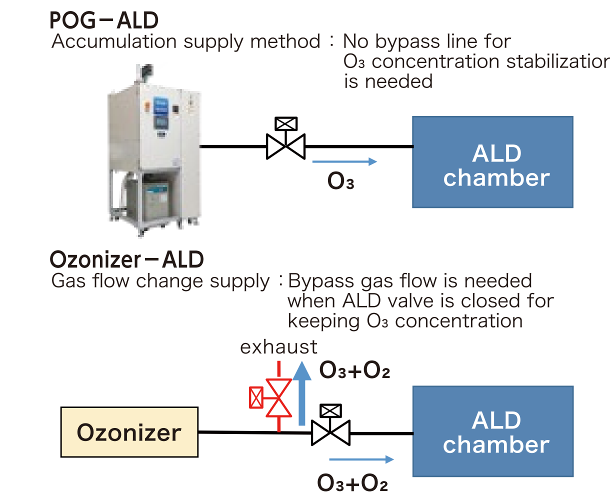
◆**[Realization of good coverage]**
Conformal coverage on sidewall and bottom of high aspect ratio trench thanks to the long lifetime of pure ozone.

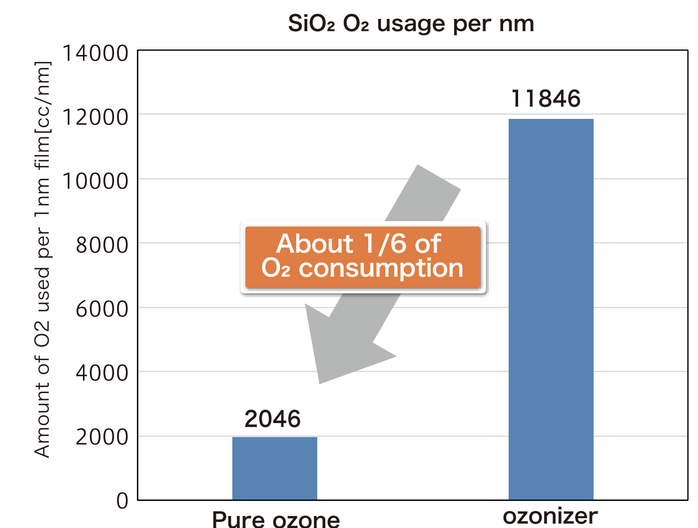
Pure Ozone Generator
Joint development with the National Institute of Advanced Industrial Science and Technology (AIST)

Superiority of Pure Ozone (vs low concentration ozone)

■ Difference in O_2 gas consumption during SiO_2 deposition

Oxidation source : Pure Ozone (PO) / Ozonizer Ozone (OZ)
SiO_2 source gas : ORTHRUS (registered trademark of Air Liquide)





Realizing high gas utilization efficiency by "on-demand supply" of pure ozone

Oxidation source supply for multiple ALDs

Example of oxidation source supply for ALD

Connection image of POG and conventional ALD equipment

Has been adopted by a major ALD equipment manufacture

Functions and specifications achieved by POG

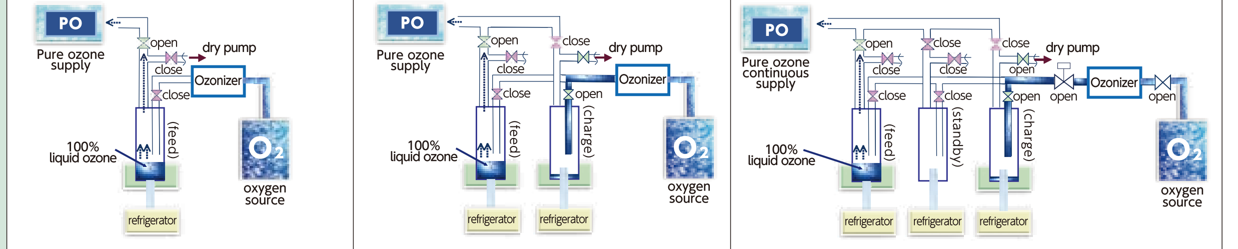
「Long continuous feeding time」
10 hours or more enough for one complete ALD process.

「Long lifetime of ozone」
Ozone concentration stability, such as ozone decomposition of 10% or less in 10 minutes.

「Simultaneous support for multiple ALD deposition systems」
Simultaneous supply of ozone to multiple ALD systems is possible.

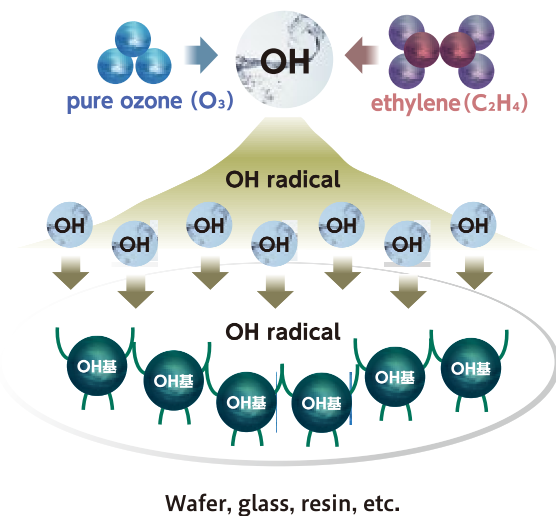
Line-up POG for ALD

Type	Batch		Quasi-continuous		Continuous supply
Intended use	for R&D		for semi-mass production		for mass production
Number of ozone chambers	1		2		3
Standard full ozone accumulation volume	①8,000cc	②16,000cc	③16,000cc	④32,000cc	48,000cc
Ozone flow rate	①10～150sccm	②10～300sccm	③10～40sccm	④10～150sccm	10～150sccm
Unit configuration	Affordable entry R&D type with one ozone chamber configuration. When Pure Ozone runs out, it will take about 2 hours to accumulate full.		A quasi-continuous supply system that repeats "feed" and "charge" by using two ozone chambers. No waiting time for ozone build-up during use.		A continuous supply type that repeats "feed", "standby" and "charge" with three ozone chambers. No waiting time for ozone build-up during use.



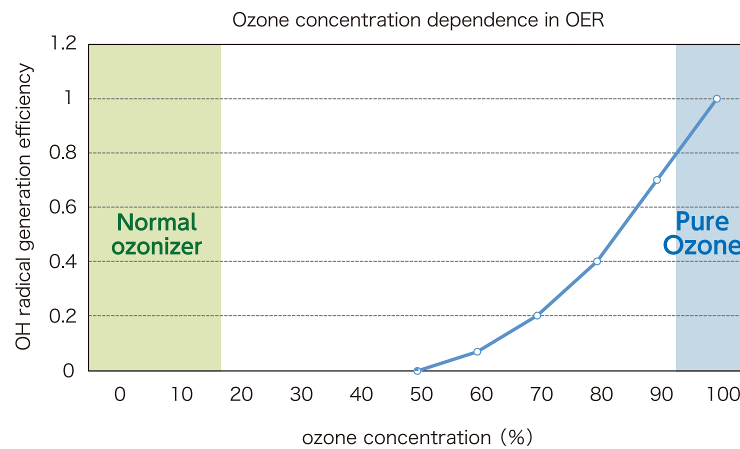
Application development of pure ozone – Surface modification in low temperature range –

Mechanism of Ozone Ethylene Radical (OER) generation



Patented (patent number：5287558)

- High-concentration ozone enables the generation of highly active OH radicals by mixing with ethylene.
- By optimizing the pressure ratio of ozone and ethylene, it is possible to maximize the amount of OH radicals generation.



Room temperature OER surface cleaning unit

Features

◆Room temperature reforming is possible
Modification at room temperature to 150℃, making the surface hydrophilic.

◆No damage
Achieves no substrate damage at room temperature, UV and plasma free.

◆Uniform treatment independent of surface shape
Uniform treatment regardless of surface shape due to high penetration of OH radicals.

◆High efficiency
Maximizing the amount of radical generation on the substrate by process optimization.

Unit specification example	
Usage environment	15～30℃, 35～70%RH
Unit size	1,000mm (W)×900mm (D)×1,800mm (H)
Base material size	Wafer: 6 inch Substrate (glass, resin): Φ150 or 100mm square
Process temperature	Room temperature～150℃

Uses a shower head structure (Patented)

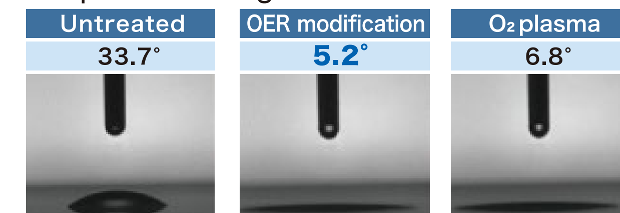
Uniform OER treatment is possible by spraying pure ozone and ethylene gas onto the base material from the shower head.

Demonstration samples of reforming and factory tours are also available. Please feel free to contact us.

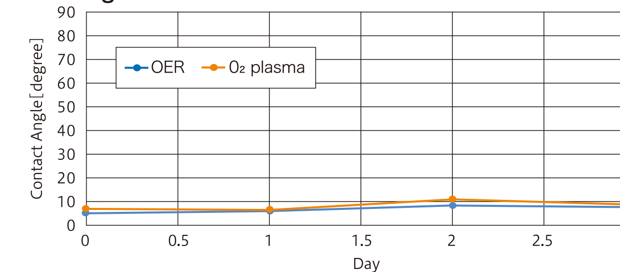
OER Examples of surface modification ・・・ Alkali-free glass

Liquid contact angle

Untreated	OER modification	O_2 plasma
33.7°	5.2°	6.8°



Change over time

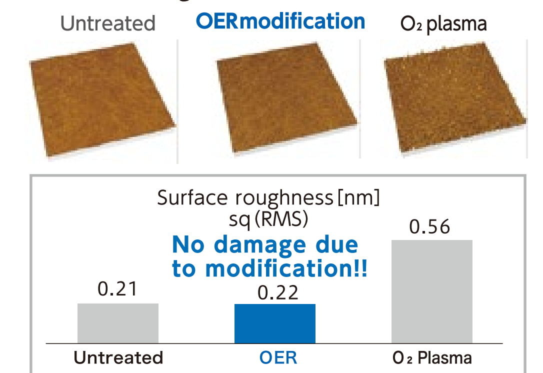


Features

◆Achieves a contact angle of less than 10°
◆Maintains smoothness without surface damage
◆Ideal for applications that require smoothness

Transfer process
Glass application
LCD panel
Semiconductor

Surface roughness

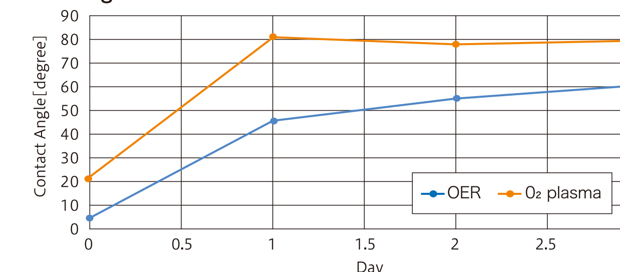


OER Examples of surface modification ・・・ PDMS

Liquid contact angle

Untreated	OER modification	O_2 plasma
90.4°	4.6°	20°

Change over time



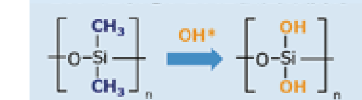
Features

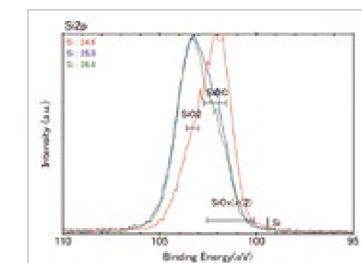
◆Achieves a contact angle of less than 10°
◆Si-OH bonds are formed

Microfluidic
Nanoimprint
Contact lenses
Medical equipment

XPS analysis

PDMS surface reaction with OH





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