February 28, 2022

Meiden NPI develops batch-type PO-ALD film deposition system Establishes world's first technology of its kind to allow atomic layer deposition at normal temperatures

A subsidiary of Meidensha Corporation (Meiden), Meiden Nanoprocess Innovations, Inc. (Meiden NPI), has developed a batch-type normal-temperature^{*1} PO^{*2} -ALD film deposition system to form high-quality oxide films, which are essential for the manufacture of semiconductor and optical products. The system is the first of its kind in the world^{*3}.

The batch-type normal-temperature PO-ALD film deposition system uses, as the oxidation source, "high-purity 100% ozone (pure ozone)" supplied from the Pure Ozone Generator, a key device of Meiden NPI. Using pure ozone gas, the system achieves a high gas wraparound property and uniform reaction, which are made possible by the absence of impurities such as H₂O, NO₂ and heavy metal, compared with film deposition with low-concentration ozone. The system enables batch processing of multiple films at a time and film deposition on various shapes, such as uneven surfaces and double-sided surfaces.

The PO-ALD film deposition system will be added to the lineup of the ALD/OER film deposition systems that was launched in 2020, aiming to expand the range of applications not only in semiconductor manufacturing, but also in various other fields such as optical device formation.

Background

Meiden's research and development of highly concentrated ozone gas started in 1998. A year after starting joint research with AIST in 2001, they developed a device capable of continuously generating high-concentration ozone. In 2012, Meiden sold its first Pure Ozone Generator to a manufacturer related to the semiconductor sector. In April 2020, Meiden spun off this business and established Meiden NPI as part of its strategy to set up a base to spur innovation for flexibly expanding business. Meiden NPI is continuing the development of processing technologies using pure ozone and proposing ways to use them so that the company can develop sales channels for the Pure Ozone Generator – a new business model it is pursuing.

• What is a Pure Ozone Generator?

The Pure Ozone Generator is a device for continuously generating pure ozone, which is ozone gas that is 100% pure and free of impurities such as heavy metals. Meiden's long track record and leading technologies have made it possible to supply toxic, explosive ozone gas in a safe, stable manner. The technology for continuously generating pure ozone is a proprietary of Meiden NPI and its co-developer, AIST. Their partnership related to pure ozone research and development has obtained many patents in Japan and overseas.



Photo 1:

Pure Ozone Generator

Developed jointly with the National Institute of Advanced Industrial Science and Technology (AIST)





PO-ALD film deposition system

This system is used in combination with the Pure Ozone Generator.

Features

1. Batch film deposition: Achieves high productivity by batch processing.

The groundbreaking thin film deposition technology maintains pure ozone gas for a long duration and enables simultaneous deposition of 25 substrates (or films) ^{*4}.

2. Deposition at normal temperature: Causes no damage to wafers thanks to no heating and no plasma process.

High reactivity of pure ozone gas allows batch (25-substrate) thin film deposition at normal temperature (30-150°C), which is impossible with plasma film deposition.

3. High trench coverage: Uniform film deposition on various shapes (concave/convex, double-sided, powder) is possible.

Due to its high wraparound property, pure ozone gas can enter deeply even into structures such as 3D objects and structures with many small grooves or holes, achieving a fourfold superior coverage compared with low-concentration ozone.

• Film types

Compatible with SiO₂, TiO₂, and Al₂O₃

[Example of use]

- Optical devices and optical products: Refractive index control and high aspect ratio are required.

 \rightarrow Can be achieved with SiO₂ and TiO₂ film deposition

- Liquid crystal display and inkjet: High water vapor barrier property and high aspect ratio are required.

 \rightarrow Can be achieved with Al₂O₃ film deposition



Example of gap coverage with SiO₂ film (high film coverage achieved)

This product also enables multilayer film deposition at normal temperature. Sharp interface formation is possible with a stacked interface width of less than 1 nm. Stacked deposition enables better control of optical properties and improvement of water vapor barrier property.



Cross-sectional depth atomic concentration profile of SiO₂/TiO₂ multilayer film

<Specifications: Batch-type PO-ALD film deposition system >

Equipment specifications	
Installation environment	15~30℃、35~70%RH
Equipment size	1350 (W) 1650 (D) 1,945 (H)
Available substrate (film) size	Wafer : 12 inches or less (Up to 100 sheets) Thin substrate (glass, resin): Φ 300, 210 mm square (Up to 100 sheets) powder : Particle size 1um or more
Film deposition temperature	50~150 $℃$ (furnace temperature with no substrate heating)
Substrate (film) load & unload	Manual (Replacement of Substrate (film) holder)
Ozone concentration	More than 90% @ gas supply port
Substrate (film) stage	Rotation enabled (10rpm~100rpm)
Safety	SEMI standard compliant (POG unit)

Based on its proprietary pure ozone processing technology, the Meiden Group will continue contributing to various markets through atomic layer deposition (ALD), a thin film forming method at the atomic level, which is required in advanced technologies.

- *1: Normal temperature: 30-150°C
- *2: PO: Meiden's proprietary technology; the abbreviation of "pure ozone"
- *3: This ALD film deposition technology using PO is the first of its kind in the world.
- *4: The number "25" is merely an example. Various numbers are available upon request.

References: Past press releases related to the topic

Meiden establishes technology to deposit oxide films at normal temperature with the use of pure ozone (April 17, 2018)

Meiden succeeds in depositing high-barrier films at normal temperature (May 15, 2019)

Notice regarding the establishment of Meiden Nanoprocess Innovation Inc. and the start of new products (March 17, 2020)

For inquiries about the product and requesting a quote Meiden Nanoprocess Innovation Inc. Website: <u>https://www.meidensha.co.jp/npi</u> Contact: Eitaro Toyama at Sales strategy office Telephone: 03-6420-8630 Email: toyama-e@npi.meidensha.co.jp