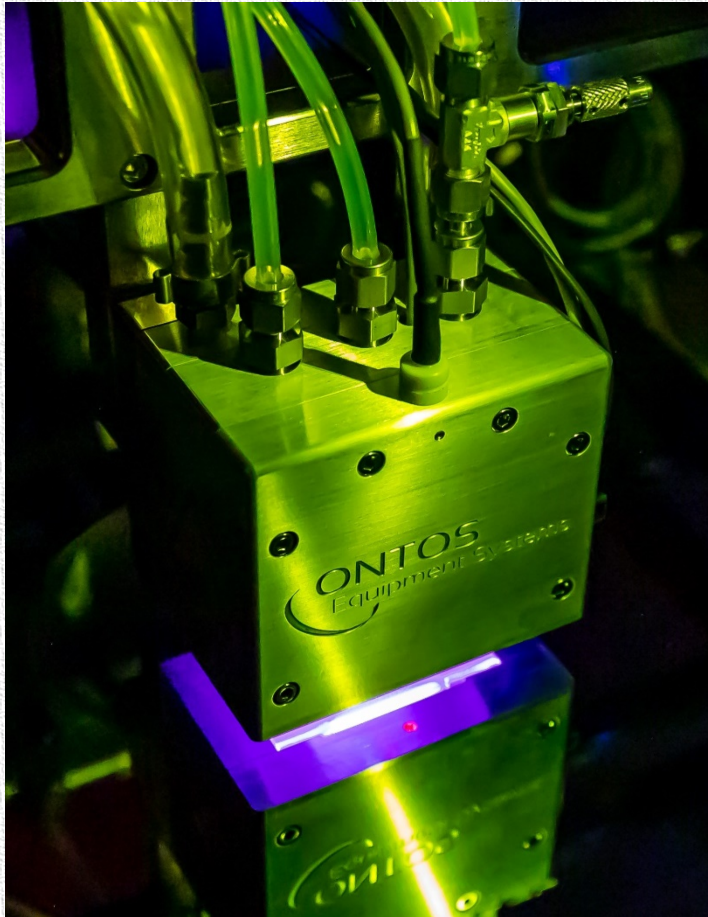
COMPETITIVE ADVANTAGES OF THE ONTOS ATMOSPHERIC PLASMA

October 2021

PREAMBLE



ONTOS is plasma system for Surface Preparation using a **patented** Atmospheric Plasma with a **unique design** enabling using **oxidizing** or **reducing** chemistry, without any modification.

ONTOS performs cleaning, eliminates the organic contamination, removes oxidation and activates surfaces.

An **Innovative Process** applies a gaseous passivation that delay the re-oxidation of the metallic surfaces.

What is Ontos Atmospheric Plasma ?

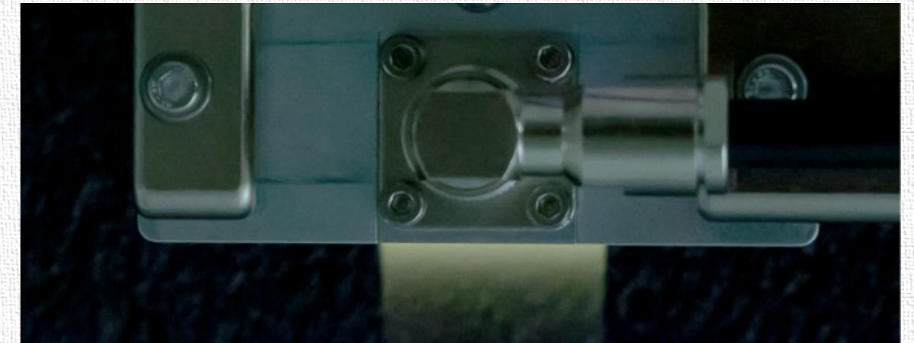
ONTOS Equipment Systems

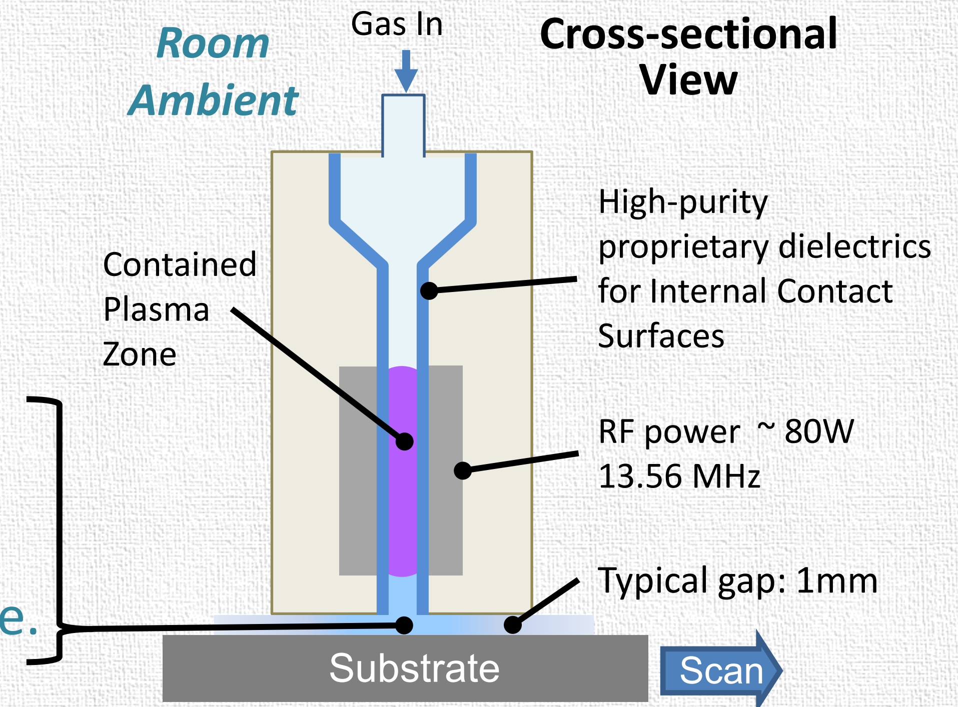
Plasma that Treat Wafers and Chips in Room Ambient

- High-Energy Species from the Plasma (ions, hot electrons), confined in the plasma head, have an extremely short lifetime at atmospheric pressure and recombine only a few microns after exiting the plasma creation zone.
- Radicals (H *, O *, N *, or others), with a longer lifetime, are still active when they come into contact with the surface of the substrate.

Downstream active radicals

- Cool gas (<100°C).
- No ions, no hot electrons.
- Outward flow excludes atmosphere from process zone.





OTHER ONTOS ATTRIBUTES

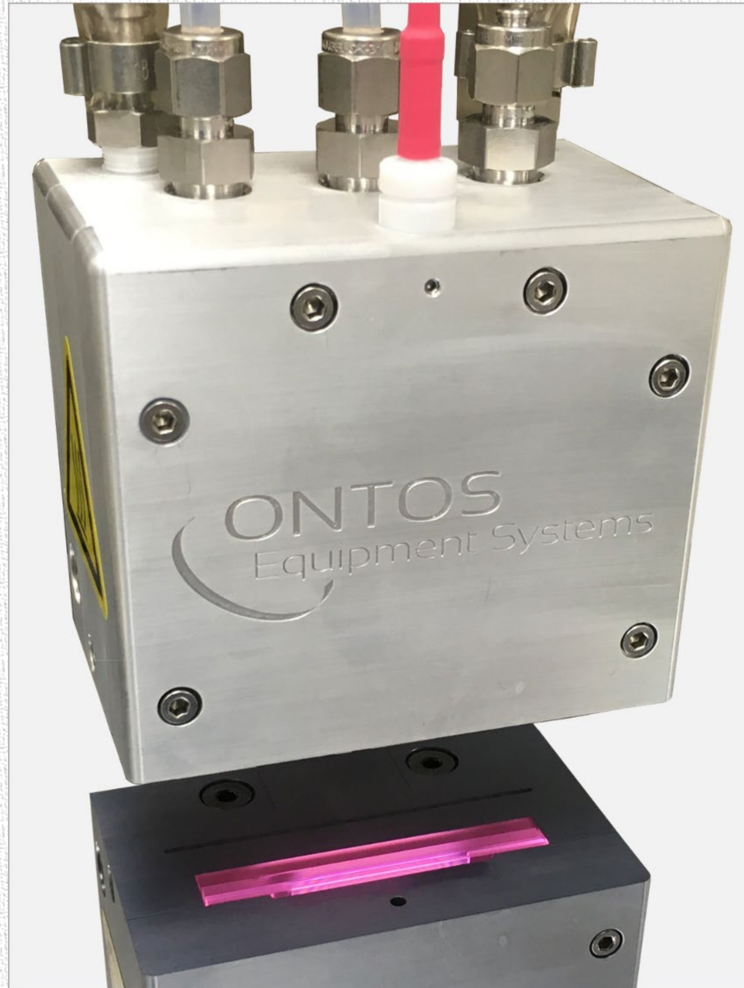
Simple, Effective and Safe Process

- **Simple** process - no vacuum chamber.
- **Fast** - completes in a few minutes
- **Downstream** radical chemistry only
- **Ultra-clean –** no particle adders or contamination.
- **Safe** for devices and personnel
  - No arc discharges, ions, bombardment,
  - re-deposition, or spalling particulates.
  - CMOS safe, compound semiconductor safe.
  - Non-toxic, dry process. OSHA- and EPA-friendly.
  - CE-Mark (third party inspection)
- **Easy Installation**
  - 120-240V / 50-60Hz Power, Process Gases, House vacuum, exhaust.

ONTOS*TT* STANDALONE TABLE TOP SYSTEM

- Table-Top design
  - 2 models are available (200 and 300mm)
  - Safety enclosure with interlocked sliding door
  - Exhaust for Ozone including air flow cooler.
  - Dimensions: W 20”, D 25”, H 18” (200mm model)
- Stationary Plasma Head, equipped with a localized substrate cooling system enabling the use of higher RF power.
- Standard Plasma Head 25 or 40 *(100mm under development)*
- X/Y/Z stage.
  - Model ONTOS*TT*-200 : 180 x 210 x 30 mm
  - Model ONTOS*TT*-300 : 280 x 310 x 30 mm
  - X/Y: Scanning substrate under Plasma Head
  - Z: Plasma-Head to Substrate Gap setting
- RF Matching Network implanted right behind the Plasma Head for stability of the Plasma.

ONTOS IS FOR INTEGRATION INTO CUSTOMER EQUIPMENT



- **OEM Components for integration into Customer Equipment.**
- **Plasma Head: Three Models currently Available.**
  - Standard Aperture 10, 25, or 40m (100mm aperture in development).
  - Compact head in development
  - Integration assistance available as an option.
- **RF Impedance Matching Network:**
  - Study of the Integration into the equipment to be carried out by the buyer.
  - The Matching Network must be placed close to the Plasma Head (Maximum Distance ~ 30cm).
- **Control Rack: Placed aside the Equipment; It includes:**
  - Power management and EPO systems.
  - Micro-controller and driver boards.
  - RF Power Generator.
  - Mass flow controllers (MFC) - 4 units installed.
  - Cooling system for plasma head.
- **Software Module**
  - For integration into the buyer's equipment and PC (dedicated PC optional)

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Advantages of the ONTOS Atmospheric Plasma Process over Vacuum RIE Plasma for Die/Wafer Surface Preparation

Advantages over Vacuum RIE (1/3)

- ONTOS Atmospheric Plasma is NOT intended to etch surfaces, it performs a surface modification process on the very top layers of the substrate.
- Atomic layers are modified by activated gas-phase chemical reactions, not blasting the surface with reactive ions.
- Eliminates the potential for vacuum plasma damage to the substrate
  - NO direct exposure to hot electrons, ions, or high kinetic energy bombardment.
- Eliminates the possibility of back-sputtering of unwanted metals from vacuum chamber components onto the substrate being treated.
- Eliminates the introduction of particles from vacuum chamber walls.
- Eliminates the possibility of re-deposition of etch products back onto the substrate being treated.

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ADVANTAGES OVER VACUUM RIE (2/3)

- Eliminates the possibility of cross-contamination of different materials or processes running on the same apparatus. No chamber walls to load up with etch by-products.
- No chamber "seasoning" required when changing processes.
- Speeds up process thruput by eliminating pump down time.
- Capable of continuous-feed process (vs. batch processing in a chamber.)
- Eliminates expensive and time-consuming maintenance requirements of vacuum equipment.
- Additionally, and very significantly, the vacuum plasma clean method only removes oxidation from metallic surfaces very temporarily, since the oxide re-grows rapidly when exposed to air after the chamber is vented. If subsequent processing cannot be performed in a very short period of time after venting, the re-grown oxide inhibits subsequent processes on oxidized metal surfaces. The ONTOS Atmospheric Plasma employs patented passivation technology to inhibit re-oxidation of metal surfaces for many hours.

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Advantages of the ONTOS Atmospheric Plasma Process over Competitive Atmospheric Plasma Products for the Preparation of Semiconductor Surfaces

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Advantages of Ontos Over Other AP Systems (1/3)

- The ONTOS Atmospheric Plasma head is specifically designed for handling both reducing chemistry and oxidizing chemistry.
- The ONTOS Atmospheric Plasma system has a strong advantage over competitors with a much broader range of operating parameters such as gas flow rates, gas ratios, and RF power.
- Only The ONTOS Atmospheric Plasma is pursuing large-format glow discharge plasma heads for use in the Semiconductor Industry. Design optimizes semiconductor processing capabilities.
- Many features of this new design are patentable.
- The ONTOS Atmospheric Plasma is stable and never arcs. Arcing in competitor's plasma occurs often and not only changes the downstream chemistry, but produces particles and eventually destroys the plasma head.
- The ONTOS Atmospheric Plasma provides 4 mass flow channels as standard equipment for process flexibility.

Advantages of Ontos Over Other AP Systems (2/3)

- The ONTOS Atmospheric Plasma head and scanning system have been designed specifically for the semiconductor industry, so as to not introduce particles onto the substrate.
- The ONTOS Atmospheric Plasma employs upstream glow discharge plasma, which we have demonstrated as safe for CMOS and other sensitive devices. Many competitors utilize arc discharge or corona discharge technology which are not CMOS-safe. These technologies typically produce extreme gas temperatures. Ontos7 gas temperature is <100°C.
- The ONTOS Atmospheric Plasma has a linear aperture for greater uniformity over large substrate areas.
- The ONTOS Atmospheric Plasma system has been designed for ease of use in semiconductor applications such as scanning chips and wafers.
- The ONTOS Atmospheric Plasma employs patented passivation technology to inhibit re-oxidation of metal surfaces while in queue.

Advantages of Ontos Over Other AP Systems (3/3)

- ONTOS Atmospheric Plasma capabilities have been proven for Indium, Nickel, Copper, Tin, Silver, and alloys of these popular contact materials, for semiconductor applications. Results have been presented at prestigious electronics industry conferences and published in conference proceedings.
- ONTOS Atmospheric Plasma has also been demonstrated as a highly effective surface activation treatment on photoresists, oxides, nitrides, semiconductors, and metals.
- ONTOS Systems engineers are participating in ongoing research into 3DIC stacking materials and processes with strategic partners.
- ONTOS Systems personnel have over 130 years of experience specifically in the semiconductor processing industry. We understand your needs and limitations, and have a very strong working knowledge of processes, diagnostic tools, associated frontend and backend process equipment, yield, thruput and cost within this industry.