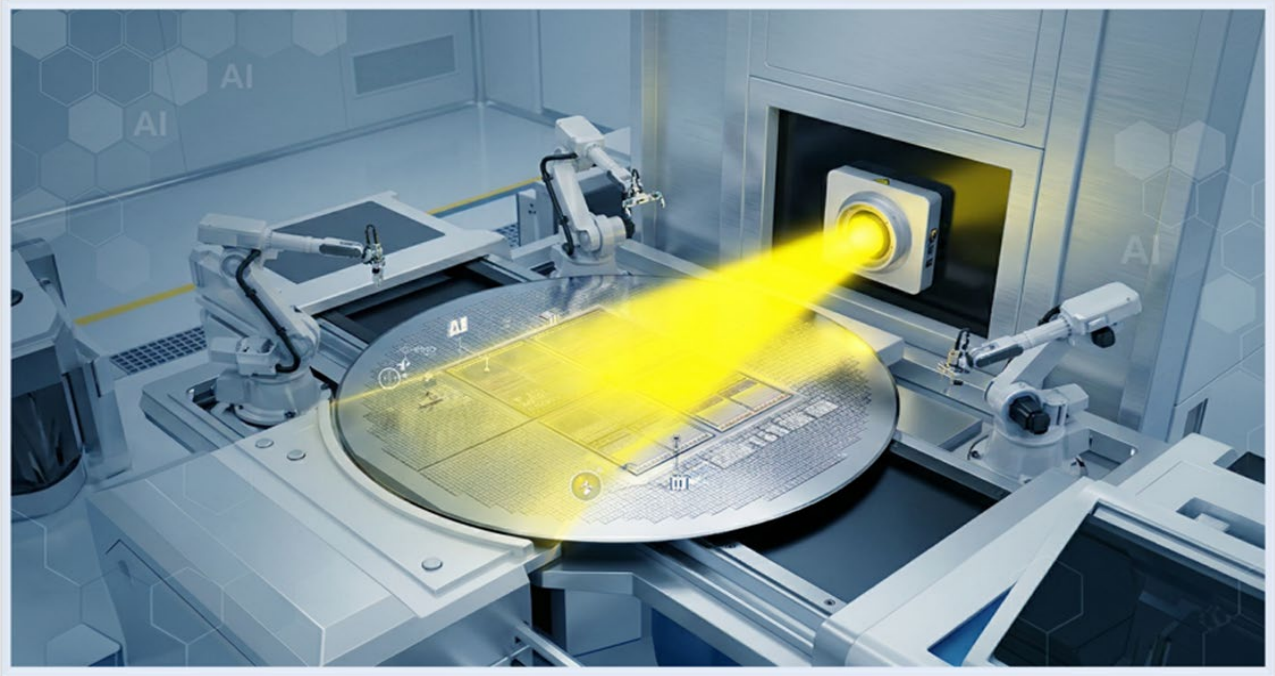
PHOTON TECHNOLOGY IN SEMICONDUCTOR & ADVANCED PACKAGING

Next-Generation Architectures Demand Next-Generation Purity

Securing the Sub-Micron Era of Hybrid Bonding, EUV, and Chiplet Integration with Zero-Particle / Perfect Balance Photon Technology.

Overview: The Sub-Micron Yield Imperative

The global semiconductor industry is entering a decisive phase driven by the explosive growth of artificial intelligence, high-performance computing, and heterogeneous integration. Global chip revenues are on track to exceed $1 trillion by 2030, with advanced packaging technologies emerging as a dominant growth engine expected to reach nearly $80 billion. As these new architectures scale down to atomic tolerances, static and contamination control is no longer a support function; it is a yield-defining discipline. To safeguard this growth, leading facilities are turning to soft X-ray photon technology. Engineered specifically for environments where even sub-micron particulate generation or turbulent airflow can cause catastrophic yield loss, photon ionization represents a paradigm shift in ultra-clean manufacturing.



Achieve Perfect Balance with Photon Ionizers

Emerging Trends & New Contamination Challenges

As the industry transitions from traditional transistor scaling toward package-level performance scaling, manufacturers are aggressively adopting Extreme Ultraviolet (EUV) lithography, Hybrid Bonding (HB), and Panel-Level Packaging (PLP). These advanced processes introduce unprecedented sensitivity to static electricity and particulate contamination.

- **Hybrid Bonding & Miniaturization:** Hybrid bonding enables direct copper-to-copper connections at pitches below 10 microns, supporting true 3D integration of logic and memory, such as 24-high High-

Bandwidth Memory (HBM) stacks. Because these surfaces must be atomically flat, a single 1 μm particle can cause a 10 mm bond void, effectively scraping the die.

- **Panel-Level Packaging (PLP):** Extending wafer-level economics to larger substrates significantly magnifies the challenges of surface flatness. The increased surface area dramatically amplifies electrostatic attraction (ESA) and particle transport.
- **EUV Lithography:** Operating in hydrogen plasma environments, EUV tools are highly susceptible to particle generation and charging. Even sub-50 nm particles on a reticle can cause repeating defects across every die on a wafer, resulting in a 100 percent yield loss for full-field dies.

To address these extreme tolerances, photon technology is being integrated directly into the most sensitive nodes of the value chain.

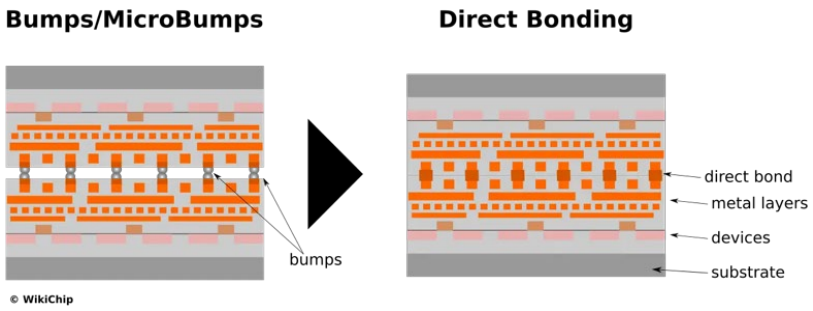
Application & Benefit Summary Matrix

Market Segment	Photon Ionizer Applications (How/Where/What)	Key Benefits vs. Corona Technology
Semiconductor - Front-End & Advanced Packaging	• Embedded in vacuum-adjacent transfer chambers & EUV tools. • Integrated into pick-and-place robotics for advanced packaging. • Direct neutralization in copper-to-copper hybrid bonding modules.	• Absolute zero particle generation • Maintains better-than-ISO Class 3 purity requirements. • Inherently balanced 0V output

Photon Purity: The Imperative for Sub-Micron Precision

This dramatic transition from visible microbumps to atomically precise, ultra-dense direct copper bonds fundamentally alters contamination tolerances. At these sub-micron scales, feature sensitivity increases exponentially. Even minor electrostatic attraction (ESA) or **a single sub-micron particle** can now cause connection voids, alignment failures, and catastrophic yield loss.

Photon technology provides the absolute purity required for these advanced nodes. Unlike traditional solutions, it ensures **zero particle generation and airflow-independent operation**, neutralizing static charge effectively in stagnant, confined air volumes—safeguarding pristine surfaces and securing yields in the sub-micron era.



Simco-Ion, Technology Group Market Fit

Simco-Ion, Technology Group's soft X-ray photon solutions, present an ideal strategic fit for the upper echelon of ultra-clean manufacturing. In critical nodes such as EUV exposure and hybrid bonding modules, where a 1 μm

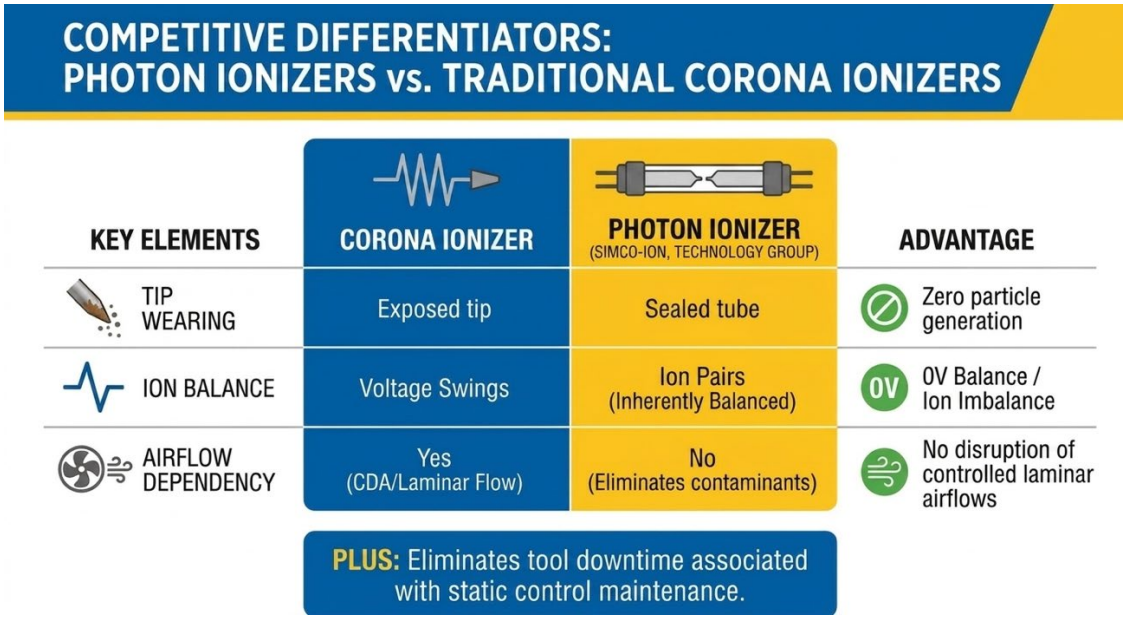
particle can cause massive bond voids, photon technology provides direct neutralization of copper-to-copper bonds.

Rather than positioning these as aftermarket cleanroom accessories, Simco-Ion engineers its solutions to be designed directly into Tier 1 automated tool architectures.

- The **Model 4901 Photon Pin Ionizer** is designed for highly confined spaces within automated assembly cells, offering fast-discharge static neutralization (<1 sec discharge time at 6 inches) without requiring an air supply. This makes it ideal for embedding into pick-and-place robotics and vacuum-adjacent transfer chambers.
- For broader coverage, the **Model 4903 Photon Bar Ionizer** provides an inherently balanced 0V output across sensitive substrates within automated metrology or roll-to-roll tooling without disrupting internal aerodynamics.

The Photon Advantage: Engineering the Future of Cleanrooms

- **Absolute Zero Particle Generation:** Traditional corona ionizers inevitably experience tip degradation over time, shedding microscopic metal or silicon particles into the environment. Photon ionizers utilize a fully sealed tube with no exposed emitter pins, guaranteeing absolute zero particle generation to safely protect better-than-ISO Class 3 environments.
- **Airflow Independence:** Corona discharge relies on forced compressed dry air (CDA) or laminar flow to push ions, which can stir up settled airborne contaminants. Photon technology instantly generates highly concentrated ion pairs in stagnant air volumes, neutralizing static without disrupting a tool's highly engineered internal aerodynamics.
- **Maintenance-Free 0V Balance:** Corona systems are prone to voltage swings that cause imbalanced ionization. Photon technology creates ion pairs simultaneously in equal numbers, delivering a perfect, inherently balanced 0V output that eliminates complex calibration routines.



Securing the Next Generation of Yield

The migration from legacy ISO Class 5-6 cleanrooms toward ISO Class 2-3 cleanliness, combined with tighter electrostatic balance, is now essential to prevent rising defect rates and reliability issues in hybrid bonding and panel-level packaging. Securing these advanced nodes requires mitigating electrostatic attraction and guaranteeing zero-particle generation. By embedding Simco-Ion, Technology Group's photon technology during the OEM design-in

phase, manufacturers can completely remove downstream integration friction and establish the mission-critical yield insurance required for the AI era

Simco-Ion, Technology Group partners with semiconductor manufacturers, OSATs, and equipment OEMs to deliver the precision ionization, real-time sensing, and data-driven process control required to support advanced packaging from pilot lines through high-volume production. Whether supporting hybrid bonding tools, panel-level packaging workflows, HBM and chiplet assembly, or next-generation cleanroom environments, Simco-Ion, Technology Group provides the platform and expertise to enable advanced packaging at scale.

Let's enable the next generation of semiconductor performance together.

Contact us at salesservices@simco-ion.com or visit www.simco-ion.com/technology to learn more.