



**KEIRONE**

**Complete Engineering Solutions...**

# About KERONE

**KERONE is one of the most admired and valuable company for customer satisfaction.**



**KERONE has reported annual revenue of \$18 to \$20 Million , increasing year-on-year.**



**KERONE is possessing employee strength of more than 280 experts continuously putting efforts for happy industrial engineering solutions**



**KERONE is possessing experience of 48+ years in engineering excellence.**

**KERONE is having immense expertise in manufacturing and implementing various types of engineering solutions.**

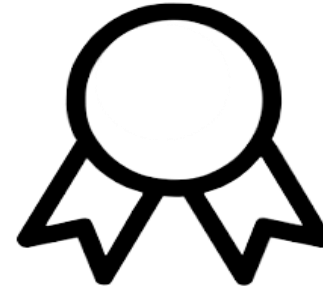
**KERONE is possessing employee strength of more than 280 experts continuously putting efforts for happy industrial engineering solutions.**





**48+**

**Years Experience**



**150+**

**Experts**



**5000+**

**Satisfied Clients**



**280+**

**Employees**

# Our Vision and Mission



## Vision

- Turn into world leader in providing specialized, top-notch quality and ecologically sustainable industrial heating, cooling , drying and engineering solution across the globe.
- To attain global recognition as best of quality and environment friendly engineering solution company.

## Mission

- To enhance the value of customer operation through our customer need centric engineering solution.
- We are committed to provide our customers, unique and best in class products in Industrial heating, drying and cooling segment, with strategic tie-up for the technical know-how with renowned leader in the industry specific segment.
- We are company that believes in strong ethics and timely commitment helps to build long term relationship.



# Value Propositions



Highly  
Customized Product



Sound  
Infrastructure



Adherence  
to  
Standards



Timely  
Delivery



Team of experts  
Delivering Quality



Cost Effective  
Solutions

# We are in collaboration with...

Member of AIMCAL



Member of IHEA



Strategic Partners of  
Emitech Italy



IRQAO Certified For  
Quality



Recognized and Rated by  
CRISIL



CRISIL Verified



Member of A.M.P.E.R.E.  
(Europe)



ASCB(E) Certification for  
Best practice



## We are Certified by...



ISO 9001:2008 | ISO 9001:2015 | OHSAS 18001 | EMS 14001

# Microwave Plasma Technology



# Introduction

- Microwave plasma technology is a field of study and application that focuses on the generation and utilization of plasma using microwave energy. Plasma is often referred to as the fourth state of matter, distinct from solid, liquid, and gas. It is an ionized gas consisting of positively and negatively charged particles.
- Microwave plasma technology harnesses microwave energy to create and sustain a plasma state. This is achieved by introducing microwaves into a low-pressure gas environment, typically using a specially designed chamber known as a microwave plasma reactor. Inside the reactor, microwaves excite the gas molecules, causing them to become ionized and forming a plasma.



# What is Microwave Plasma?

- Microwave plasma refers to a type of plasma generated using microwave energy. Plasma itself is an ionized gas composed of positively and negatively charged particles. In a microwave plasma, the plasma is created and sustained by introducing microwaves into a low-pressure gas environment.
- Microwaves offer precise control over plasma parameters such as temperature and density. By adjusting the power and frequency of the microwave energy, researchers and engineers can tune the properties of the plasma to suit specific applications.
- Microwave plasma is a type of plasma generated using microwave energy, offering efficient and controllable plasma generation for a wide range of applications.



# Operating Principle

Microwave plasma is a combination of microwave discharges generated by electromagnetic waves with frequencies exceeding 300 MHz. For obtaining the microwave discharges, plasma generators are used being called plasmatrons, which serve for supplying electromagnetic energy into the discharge volume. The generation of microwave plasma requires special devices, including a microwave oscillator, a magnetron, and waveguide equipment, which makes it possible to create an electromagnetic field with a strength exceeding 30 kV per cm in the discharge volume (resonator). In turn, it leads to the emergence of breakdown voltage and avalanche ionization of the plasma-forming gas (air, steam, inert gases, hydrogen, oxygen, etc.) as well as the formation of the plasma clot. An area of "plasma combustion" called a plasmoid is given the shape of a torch (plasma jet) with the help of an organized flow of plasma-forming gas, which is deduced outside the plasmatron. Thus, a double effect is achieved including protection of the plasmatron from overheating as well as destruction making a powerful tool for application in intensive high-temperature impact on organic and inorganic substances

# Advantages

- **Efficient and Uniform Heating**

Microwaves can penetrate deeply into the plasma, resulting in efficient and uniform heating. This characteristic ensures that the plasma is heated evenly throughout the volume, leading to consistent and predictable results in plasma-related processes.

- **Precise Control**

Microwave plasma allows for precise control of plasma parameters such as temperature, density, and composition. The power and frequency of the microwaves can be adjusted to tailor the plasma characteristics according to specific requirements. This level of control enables researchers and engineers to fine-tune the plasma chemistry and optimize process outcomes.

- **Low-Pressure Operation**

Microwave plasma can be generated at relatively low pressures, typically in the range of a few millibars to a few hundred millibars. This lower pressure range makes microwave plasma suitable for a wide range of applications, including those requiring delicate materials or sensitive substrates.

# Advantages

## ■ **Reduced Environmental Impact**

Microwave plasma technology often operates at lower pressures and temperatures compared to other plasma generation methods. This reduced energy requirement contributes to lower environmental impact and energy consumption. Additionally, microwave plasma can be used for environmentally friendly processes such as waste treatment and pollution remediation.

## ■ **Rapid Start-up and Shutdown**

Microwave plasma systems can achieve rapid start-up and shutdown times, allowing for increased process efficiency and productivity. This feature is particularly valuable in industrial applications where quick turnaround times are essential.

# Applications

## ■ **Materials Synthesis**

Microwave plasma technology is used for the synthesis and processing of various materials. It enables the production of nanoparticles, nanostructures, and thin films with controlled properties. Microwave plasma-assisted synthesis allows for precise control over the size, composition, and morphology of nanoparticles, making it valuable for applications in catalysis, energy storage, and biomedical fields.

## ■ **Environmental Applications**

Microwave plasma is utilized in environmental applications, such as waste treatment and pollution control. It can be employed for the destruction of hazardous organic compounds in waste streams, including volatile organic compounds (VOCs) and persistent organic pollutants (POPs). Microwave plasma technology offers efficient decomposition and conversion of these pollutants into less harmful byproducts. It is also used for air purification by removing pollutants, odors, and volatile organic compounds from indoor and industrial environments.

# Applications

## ▪ **Semiconductor Industry**

Microwave plasma is widely used in the semiconductor industry for processes such as plasma etching and deposition. Plasma etching involves selectively removing material from semiconductor wafers to create intricate patterns and structures. Microwave plasma provides precise control over etching rates and selectivity, enabling high-resolution patterning. Plasma deposition, on the other hand, involves depositing thin films of materials onto semiconductor surfaces, and microwave plasma allows for uniform and controlled deposition processes.

## ▪ **Surface Modification**

Microwave plasma is employed for surface modification of materials, including cleaning, activation, and functionalization. Plasma-assisted surface cleaning removes contaminants, oxides, and organic layers from various substrates, enhancing their surface properties. Microwave plasma is also used for surface activation, improving the adhesion properties of surfaces for bonding, coating, or printing processes. Furthermore, plasma functionalization enables the introduction of desired chemical groups onto material surfaces, imparting specific properties such as hydrophobicity or biocompatibility.



# Applications

## ■ **Biomedical and Life Sciences**

Microwave plasma has applications in the biomedical and life sciences fields. It can be used for sterilization of medical instruments, surfaces, and packaging materials due to its ability to efficiently eliminate microorganisms. Additionally, microwave plasma-assisted processes can modify the surface properties of medical implants, enhancing their biocompatibility and bioactivity. Furthermore, microwave plasma is used for cell culture surface activation, tissue engineering, and biomaterial modification.

## ■ **Energy and Environmental Remediation**

Microwave plasma is explored for energy-related applications, such as the production of clean fuels, synthesis of hydrogen, and carbon dioxide conversion. It can assist in the production of syngas (a mixture of hydrogen and carbon monoxide) from renewable resources. Moreover, microwave plasma is investigated for environmental remediation purposes, including the decomposition of pollutants in soil and water, and the treatment of wastewater.



# Industrial Uses

## ■ **Materials Processing**

Microwave plasma is employed in materials processing applications for surface treatment, coating deposition, and modification of material properties. It is used for surface cleaning and activation of materials before bonding, painting, or coating processes. Microwave plasma-assisted deposition techniques enable the production of thin films with specific properties, such as wear resistance, corrosion protection, or optical properties.

## ■ **Semiconductor Manufacturing**

Microwave plasma technology is extensively used in the semiconductor industry for processes like plasma etching, plasma-enhanced chemical vapor deposition (PECVD), and atomic layer deposition (ALD). Plasma etching is used to pattern and etch semiconductor materials during device fabrication. PECVD and ALD processes utilize microwave plasma to deposit thin films for various purposes, including dielectric layers, barrier films, and conductive materials.

# Industrial Uses

## ■ Surface Modification and Activation

Microwave plasma is employed for surface modification and activation of materials in industries such as automotive, aerospace, and electronics. By treating the surface with microwave plasma, adhesion properties can be improved, promoting better bonding and coating adhesion. This is particularly valuable for enhancing the performance and durability of components in these industries.

## ■ Food Industry

Microwave plasma technology is used in the food industry for surface decontamination and sterilization of food packaging materials. The microwave plasma treatment helps in reducing microbial contamination on the surface of packaging materials, extending the shelf life of food products and ensuring their safety.



# Industrial Uses

## ■ Waste Treatment and Remediation

Microwave plasma is utilized for waste treatment applications, including hazardous waste remediation, treatment of industrial effluents, and wastewater purification. The high-energy plasma generated by microwaves can decompose and destroy organic pollutants, transforming them into less harmful byproducts. This technology offers an environmentally friendly approach to waste treatment, minimizing the release of hazardous substances into the environment.

## ■ Textile and Fiber Industry

Microwave plasma technology finds application in the textile and fiber industry for surface modification and functionalization of fabrics. It can be used for improving properties such as water repellency, stain resistance, anti-bacterial properties, and flame retardancy. The controlled and localized treatment provided by microwave plasma enables precise modification of textile surfaces without affecting the bulk properties of the material.

# Research and Development

## ■ Plasma Physics and Chemistry

Research focuses on understanding the fundamental processes occurring in microwave plasmas, including plasma generation, plasma-surface interactions, and plasma chemistry. This involves studying the kinetics of plasma reactions, energy transfer mechanisms, and the behavior of reactive species. The aim is to improve the understanding of plasma phenomena and optimize plasma parameters for specific applications.

## ■ Plasma Diagnostics and Characterization

Development of advanced diagnostic techniques is essential for studying and characterizing microwave plasma. Researchers work on developing diagnostic tools to measure plasma parameters such as electron density, electron temperature, gas composition, and plasma uniformity. These diagnostics help in optimizing plasma conditions and understanding the underlying plasma physics.

# Research and Development

## ■ Plasma Sources and Reactor Design

Researchers focus on developing innovative plasma sources and reactor designs for efficient and controlled plasma generation. This involves designing novel microwave applicators, resonators, and waveguides to improve plasma uniformity, stability, and energy efficiency. Different reactor geometries and configurations are explored to enhance plasma processing capabilities and scalability.

## ■ Plasma-Materials Interactions

Understanding the interactions between microwave plasma and materials is crucial for optimizing material processing and surface modification. Researchers investigate plasma-material interactions to determine the effects of plasma exposure on material properties, such as surface roughness, chemical composition, and mechanical integrity. This knowledge helps in developing tailored plasma processes for specific materials and applications.

# Research and Development

## ■ **New Material Synthesis and Functionalization**

R&D efforts focus on using microwave plasma to synthesize new materials, such as nanoparticles, nanostructures, and thin films, with unique properties. Researchers explore novel precursor chemistries, plasma conditions, and reaction pathways to precisely control the size, composition, and morphology of the synthesized materials. Additionally, microwave plasma is used for functionalizing materials by introducing desired surface modifications or chemical groups.

## ■ **Energy and Environmental Applications**

R&D efforts aim to explore and optimize the use of microwave plasma for energy-related applications, such as clean fuel production, hydrogen generation, and carbon dioxide conversion. Researchers also investigate the potential of microwave plasma for environmental remediation, including the treatment of air and water pollutants, soil remediation, and waste-to-energy conversion.

# Research and Development

## ■ **Process Optimization and Scale-up**

Researchers work on optimizing microwave plasma processes to improve efficiency, productivity, and scalability. This involves developing control strategies, process modeling, and optimization algorithms to achieve desired process outcomes. Scaling up microwave plasma technology from laboratory-scale to industrial-scale processes is also a focus of research and development efforts.

## ■ **Multi-Physics Modelling and Simulation**

Computational modelling and simulation play a crucial role in microwave plasma research and development. Researchers develop multi-physics models to simulate plasma behavior, electromagnetic fields, and plasma-material interactions. These simulations help in understanding complex plasma phenomena, optimizing process parameters, and predicting outcomes.

# Conclusion

- Microwave plasma technology offers a range of advantages and applications across different fields. Its efficient and uniform heating, precise control, scalability, versatility, and reduced environmental impact make it a valuable tool for various processes and industries. Microwave plasma finds applications in semiconductor manufacturing, surface modification, materials synthesis, environmental remediation, and biomedical fields, among others.
- As research and development continue to push the boundaries of microwave plasma technology, it is likely to play an increasingly important role in addressing various industrial and societal challenges. The versatility and potential of microwave plasma make it a technology to watch, with the possibility of further innovations and breakthroughs that can contribute to advancements in science, engineering, and industry.



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# Serving Across Borders...





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