EXPLANATION OF LOW PRESSURE PLASMA CLEANING

ADVANCED TECHNOLOGY FOR RESEARCH & INDUSTRY

KNOWLEDGE BASE FACT SHEET

- SCOPE: Explanation of the process and use of Low Pressure Plasma cleaning.

Low Pressure Plasma Treatment uses controlled vacuum plasma to alter the surface of a material in order to improve bonding, printing, painting, coating, or wettability. The process is performed in a plasma chamber under vacuum pressure. It is commonly used in the manufacturing of electronic devices. Nearly any dry material can be treated in a plasma chamber.

Low Pressure Plasma Cleaning involves the removal of impurities and contaminants from surfaces through the use of energized plasma created from gaseous species. Gases such as Argon and Oxygen, as well as mixtures such as air and Hydrogen/Nitrogen are used. The plasma is created by using high frequency (RF) voltages (typically >10MHz) or Microwave frequency voltages to ionize the low-pressure gas (typically around 150mTorr-400mTorr), although atmospheric pressure plasmas are now also common.

In plasma gas atoms are excited to higher energy states and also ionized. As the atoms and molecules 'relax' to their normal, lower energy states they release a photon of light, this results in the glow or light associated with plasma. Different mixtures of process gases give different colours. For example, oxygen plasma emits a light blue colour where as an oxygen / argon mixture is pink.

Plasma's activated species include atoms, ions, electrons, free radicals, free radicals, metastables, and photons in the short wave ultraviolet (vacuum UV, or VUV for short) range. This 'mixture', which incidentally is around room temperature, then interacts with any surface placed in the plasma chamber.

Depending on the power of the RF energy supplied, a side effect of the Plasma process is that the part been treated can rise in temperature. Although temperature controlled chambers can be used to control and increase the cleaning/etch rate (60-90 degrees Celsius can increase the etch rate to up to four times.), temperature sensitive components can be processed at >15 degrees Celsius.

If the gas used is oxygen, the plasma is an effective, economical, environmentally safe method for critical cleaning. The VUV energy is very effective in the breaking of most organic bonds (i.e., C–H, C–C, C=C, C–O, and C–N) of surface contaminants. This helps to break apart high molecular weight contaminants. A second cleaning action is carried out by the oxygen species created in the plasma (O_{2+}, O_{2-}, O_3, O, O_+, O_-, ionised ozone, metastable excited oxygen, and free electrons). These species react with organic contaminants to form H_2O, CO, CO_2, and lower molecular weight hydrocarbons. These compounds have relatively high vapour pressures and are evacuated from the chamber during processing. The resulting surface is ultra-clean.

If the part to be treated consists of easily oxidised materials such as silver or copper, inert gases such as argon or helium are used instead. The plasma activated atoms and ions behave like a molecular sandblast and can break down organic contaminants. These contaminants are again vaporized and evacuated from the chamber during processing.

Low Pressure Plasma Treatment systems are able to remove 100% of these organic contaminants. This increases the bond strength of a solder or glue, increases or decreases wettability, and ensures any type of printing, painting, or coating remains on the object's surface.

Typically, Low Pressure Plasma Cleaning process can last between 2-20 minutes, upon completion of the plasma cycle, the process chamber is evacuated under vacuum finally to remove any containment from the Plasma process.