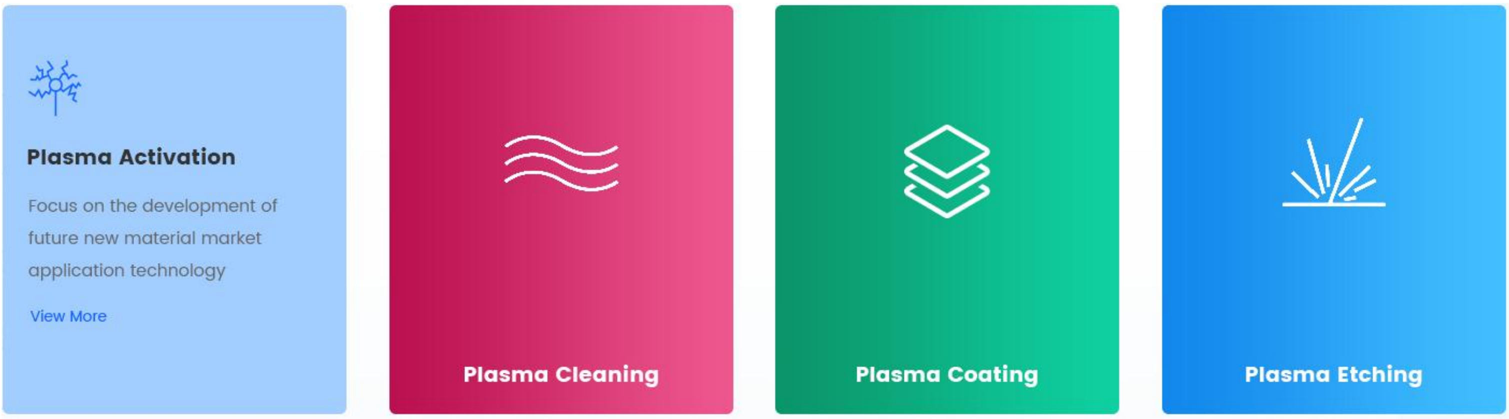
# NE-PE60F

## Low-pressure plasma cleaning system

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# 1. Equipment introduction

## 1.1 NE-PE60F Overview

NE-PE60F is a large-scale industrial vacuum plasma treatment system, Equipped with large high performance vacuum chamber and plasma electrode system, it is suitable for large-scale continuous production. NE-PE60F uses high performance vacuum pump to rapidly produce ultra-low vacuum pressure. At the same time, according to the process requirements of customers, different mixed process gas is passed into the vacuum reaction chamber, and high quality high-frequency plasma generator is adopted to make the process gas to generate plasma, and ensure the stable production of high density and high energy ions. The plasma interacts with the material through complex physical and chemical reactions to achieve different process functions, such as cleaning, activation, etching and coating. The plasma state is notable for its highly homogeneous glow discharge, which emits visible light in colors ranging from blue to deep purple depending on the gas.

Schematic diagram of equipment principle (fig. 1)

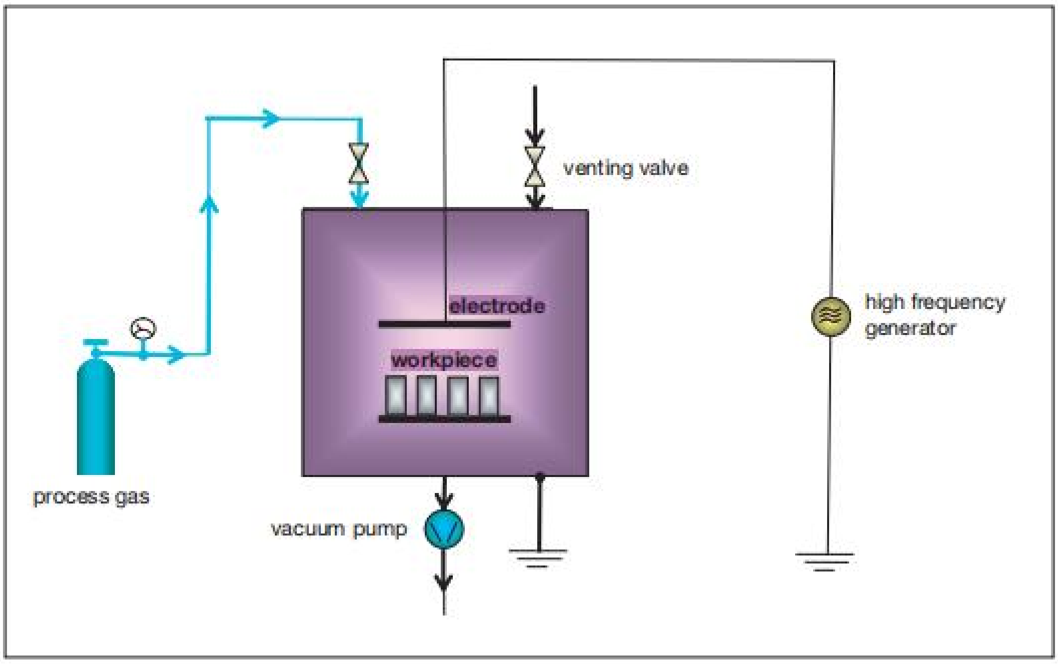
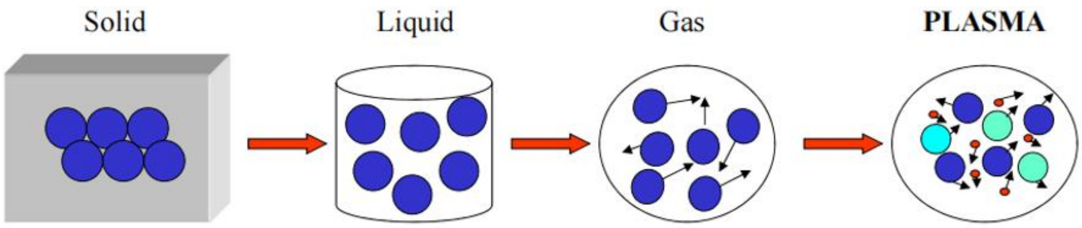



fig. 1: schematic of 13.56MHz plasma systems

## 1.2 What is plasma?

If you continuously apply energy to matter, its temperature is rising and undergoes the process from solid-state to liquid and gas. Carrying on applying energy the existing shell of the atom is breaking up and electrically charged and excited particles and molecule fragments are formed (negatively charged electrons and positively charged ions, radicals). This mixture is called plasma or the fourth state of matter (aggregate state).

In short: changes of the aggregate state under applied energy:




In nature plasma is found in lightning, the Northern Lights, flames and in the sun. Artificially
created plasma is known among other things in neon tubes, welding and flashlights.
Schematic of a plasma chamber:

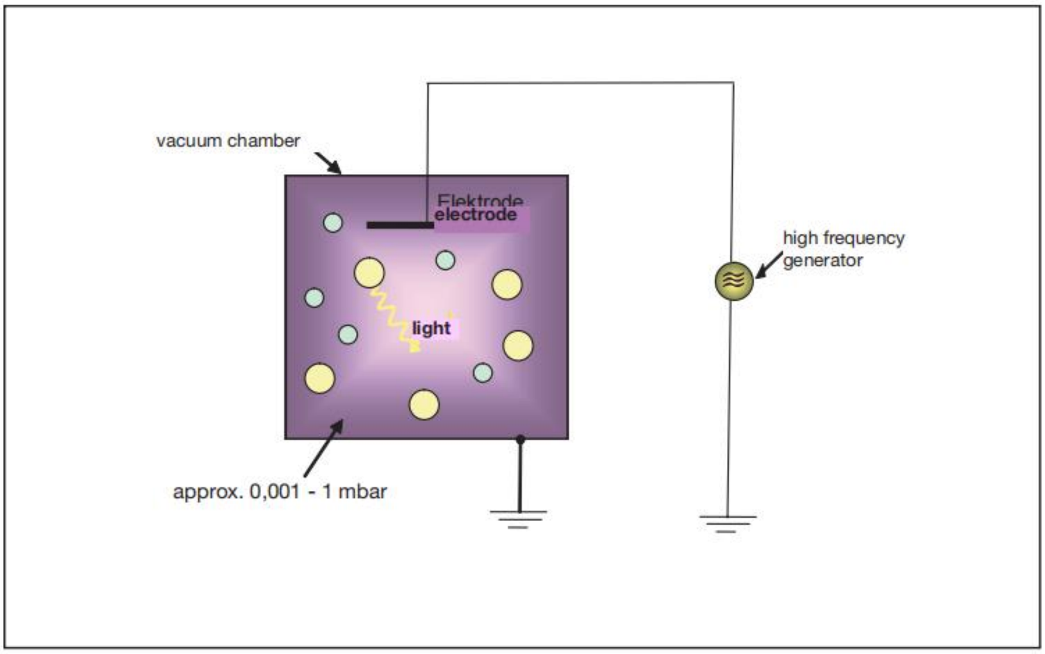



fig. 2: schematics of a plasma chamber

In plasma processes different effects are made use of.

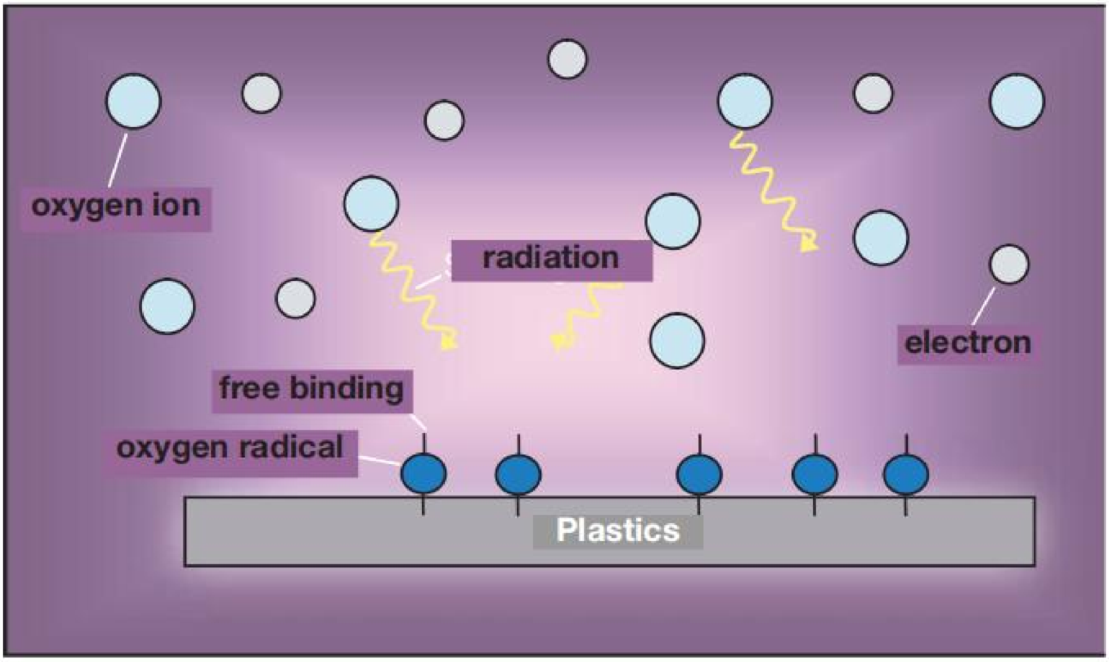



fig. 3: effects on plasma process

To some extent the surface of parts to be treated is only mechanically "micro-sandblasted" by energy-rich gases (i.e. inert gas plasma). The emerging plasma reacts chemically with the

treated part (i.e. oxygen plasma). The IR/UV-radiation content of plasma is breaking down carbon chains, with oxygen providing a greater surface for reaction and radical points are created. (fig. 3)

## 1.3 Applications of Low-pressure plasma technology

### 1.3.1 Cleaning

Some components are covered with grease, oils, wax and other organic or inorganic contaminants (also oxide layers).

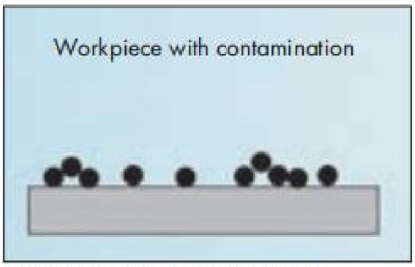


fig. 20: Before plasma treatment

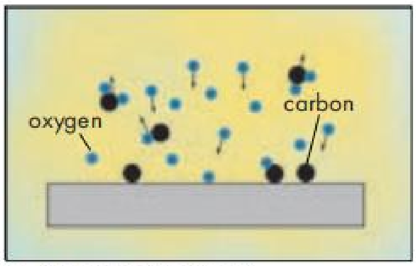


fig. 21: plasma treatment

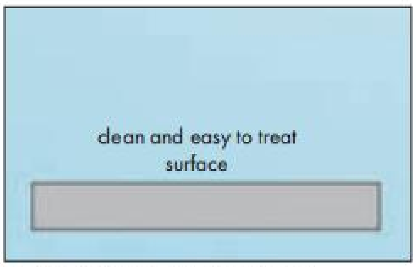


fig. 22: After plasma treatment

For certain applications it is essential that completely clean and oxide-free surfaces are achieved. For example:

- Before **sputtering processes**
- Before **lacquering processes**
- Before **gluing**
- Before **printing**
- In **PVD and CVD Coating**
- In **special medical applications**
- With **analytical sensors**
- Before **bonding**
- Before **soldering of conductor plates**
- With **switches etc**

In these cases plasma reacts in two different forms:

A. It removes organic layers:

- These are chemically attacked by oxygen or air (fig. 20-22)
- By low-pressure and heating on the surface contaminants partially evaporate
- By energy-rich particles in plasma contaminants are broken down into smaller molecules and therefore can be sucked off
- Also UV radiation can destroy contamination

Contamination should only be a few micrometres thick, since plasma is only capable of cleaning away a few nm/s.

For example grease contains lithium compounds. Only organic constituents can be removed from those. The same applies to fingerprints.

B. **Reduction of Oxides:**

- Metal oxide chemically reacts with the process gas (fig. 23-25). Pure hydrogen or a mixture of argon and nitrogen is used as a process gas.

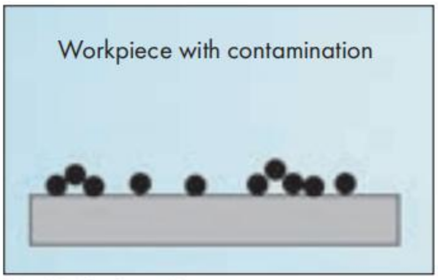


fig. 20: Before plasma treatment

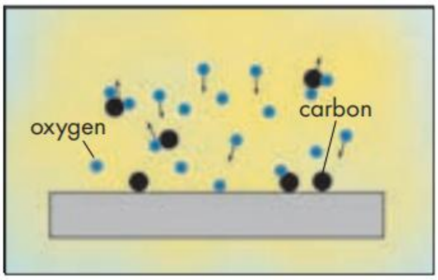


fig. 21: plasma treatment

fig. 22: After plasma treatment

## 1.3.2 Activation

**Soldering:**

Following processes are possible for pre-treatment of soldering:

a) Soldering under vacuum: For special applications soldering under vacuum is possible. In this case no flux is required.

b) Long-term stored electrical components, which have oxidised over time. Oxidation can be eliminated by hydrogen plasma.

**Bonding:**

Often **organic contaminants**, in example, residua of electroplating processes, of adhesives, of flux residuals etc. disturb bonding. These can be removed by plasma. Equally **oxide layers** can worsen the bonding process. These can be reduced by hydrogen plasma

### 1.3.3 Etching

In plasma etching gases are used which can create a phase change of the etched material (e.g. etching of silicon containing fluorine gas, fig. 48-50). The gas enriched by base material is sucked up and fresh gas introduced. In this way continuous extraction is achieved. Applying a resistant etching mask (e.g. chromium) to the process gas used, areas can be protected. Hereby a surface area can be systematically structured. These structures are of nanometre magnitude.

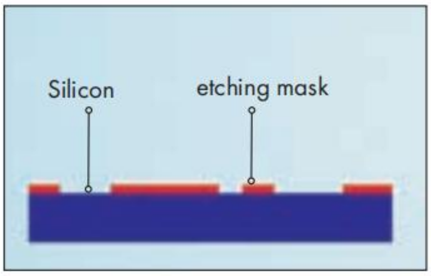



fig. 48: silicon with etching mask before plasma treatment

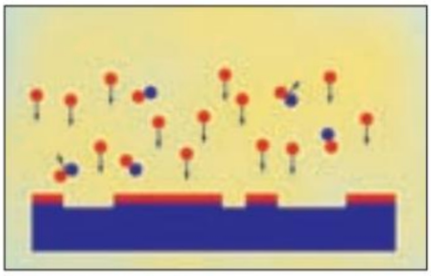


fig. 49: plasma treatment

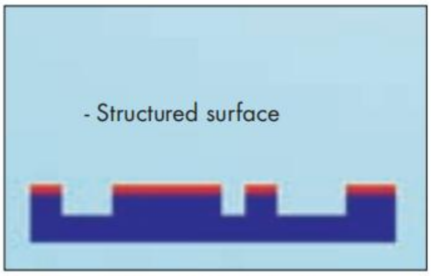



fig. 50: after plasma treatment

## 1.4 Comparison of plasma treatment effect

**Contact Angle Measurement:**

This process measures the **contact angle** (fig. 36) of a water droplet with regard to surface
area of activation. The better the activation, the more flattened is the water droplet on the
surface. However, this process is rarely applied since measuring equipment is relatively
expensive and generally cannot be measured immediately on site.

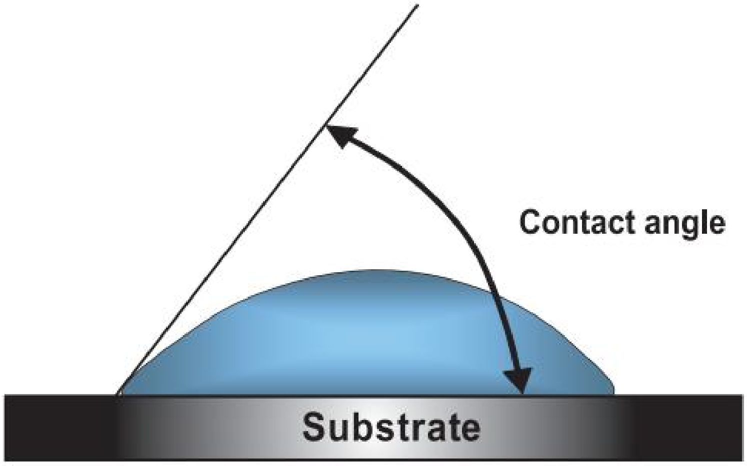



fig. 36: contact angle

Example of photos (taken under the microscope)

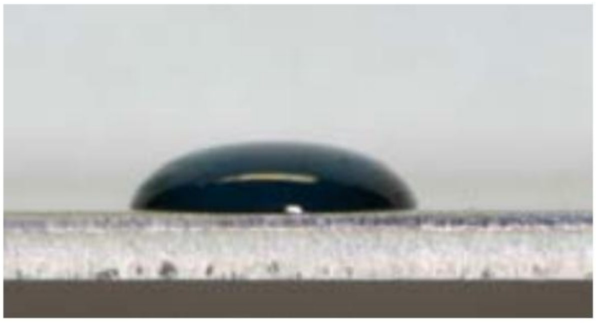


fig. 37: untreated surface

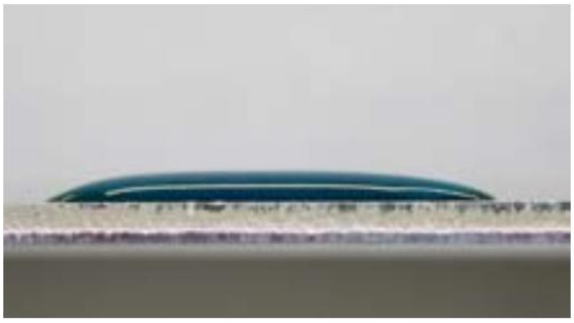


fig. 38: activated surface

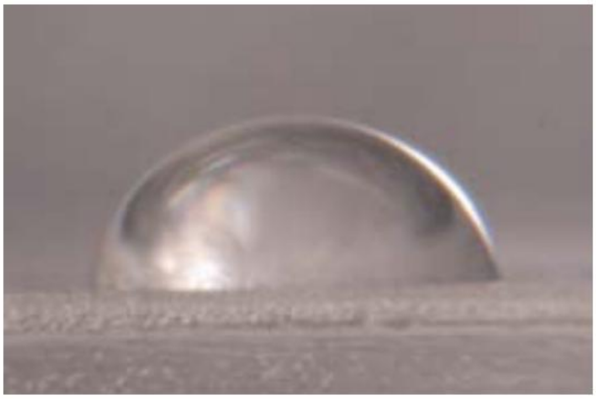


fig. 39: untreated surface

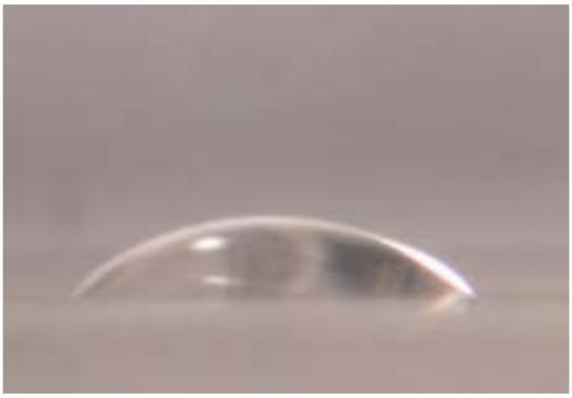


fig. 40: activated surface

**Dyne value Measurement:**

The other process uses different test inks. Depending on the course of these test inks,
a designated surface energy can be assigned to these treated parts. The unit is mN/m [formerly: dyn/cm].

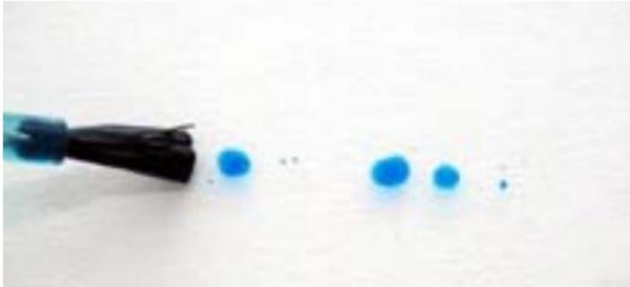


fig. 41: untreated surface (< 28 mN/m)

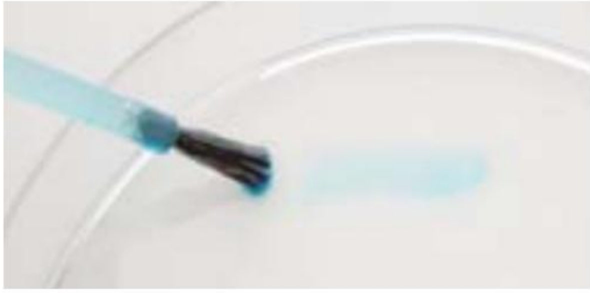


fig. 42: treated surface (72 mN/m)

## 2. Features and Benefits

- **Excellent uniformity**
- **Low ion energy, no damage substrate**
- **No electrode and substrate contamination**
- **Patented special plasma electrode**
- **High density plasma source**
- **High plasma efficiency and high cleaning efficiency**
- **Low ionic energy can be controlled**
- **Combined with chemical reactivity and physical impact**
- **Fast processing speed, high cleaning efficiency, high reliability**
- **Wide operating range**
- **A variety of process gases can be used**
- **Fully automatic and easy to operate**
- **The equipment is stable and high, easy to maintain**
- **Can be changed according to customer requirements**

## 3. Technical parameters

| No | System composition | Items | Parameters |
|---|---|---|---|
| 1 | Chamber | Number of Available Cells | 6 |
| | | size | 400(W)*450(D)*370(H)mm; 60L |
| | | Material | 316 stainless steel, military grade seal |
| | | Available processing Size | W370mm x D370mm |
| 2 | Electrodes | type | Powered;Ground;Floating |
| | | Material | high conductivity alloy electrode plate. |
| 3 | Vacuum Pump | Rotary vane pump | Pumping speed: 65m3/H |
| 4 | RF Power | Standard Wattage | 1kw |
| | | Frequency | 13.56MHZ |
| 5 | Gas Control | Reactants | $O_2$ , $H_2$, Ar , $N_2$, Mixing gases |
| | | Number of MFCs | 2 |

| | | | |
|---|---|---|---|
| 6 | Process Facilities | Power Supply | 380V, 5KW,3-Phase + Ground; 50/60 Hz |
| | | Process gas purity | 99.99% |
| | | Process Gas Pressure | 1.03 bar (15 psig) min. to 1.7 bar (25 psig) max., regulated |
| | | Pneumatic Gas Purity | CDA, Oil Free, Dewpoint ≤7° C (45° F), Particulate Size <5 μm |
| | | Pneumatic Gas Pressure | 0.6~0.8MPa |
| | | installation environment | Temperature below 40 degrees Celsius, humidity below 85 |
| | | Exhaust | Equipped with waste gas treatment tower or connected with factory acid exhaust, static exhaust pressure is no less than 5psi, inch and half exhaust pipe |
| 7 | Control Systems | touch panel | 7.0 inches |
| | | PLC | Mitsubishi PLC module |
| 8 | Machine Dimensions | size | 900mm(L)×960mm(W) ×1750 mm(H) |
| | | Weight | 400 kg |

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