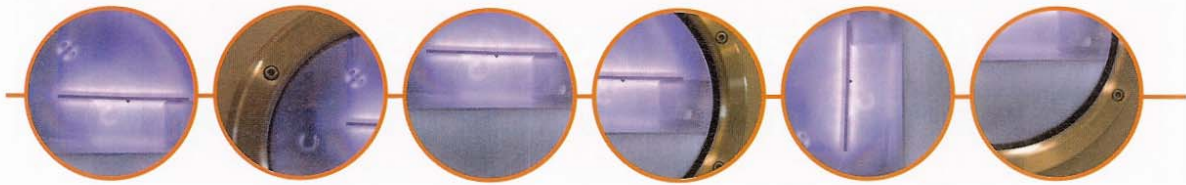


market place



Plasma Processing of Surfaces

Plasma technology can help meet the increasingly stringent demands placed on medical device surfaces.

The technique

Compatibility with the biological host, cleanliness and intrinsic reliability are all crucially affected by surface properties. Plasma processing is a low-temperature technology that enables surfaces to be prepared or modified in a controlled, clean and precise way (Figure 1). Cleaning, etching and chemical or mechanical modification or enhancement are achieved without substrate heating, surface damage or any undesirable secondary oxidation (Figure 2).

Plasma is a fluid in a highly excited state that contains atoms, meta-stable molecules, ions and electrons and photons held at temperatures of several thousand degrees Kelvin. The plasma is generated as a glow discharge by applying an electric field (radio or microwave frequencies) in a low-pressure (typically 0.1–0.4 Torr) vacuum environment. The properties achieved depend on the gas elements employed in the process. Changes produced in the plasma can be mechanical, physical or

chemical. For example, if argon is used, because of its nonreactive, inert qualities, it can mechanically remove molecules from the surface to produce microalterations in the surface texture that provide a spectrum of results ranging from cleaning and roughening to etching. If oxygen is used, its highly reactive nature promotes oxidation to produce reactive surfaces on silicones or polytetrafluoroethylene and high levels of adhesion can be achieved for biofilms, adhesives or other bonding or sealing operations. Application of voltage in a near-vacuum allows low densities of ions to move at high speed (and thus high energy) close to the surface of the workpiece. The normal electric field attracts the plasma to the surface, which enables extremely high energies to be confined to thin layers without mass heating. On collision with the surface, species are removed by the collision energy or the species from the plasma react with the surface to produce the required new surface chemistry.

Properties delivered

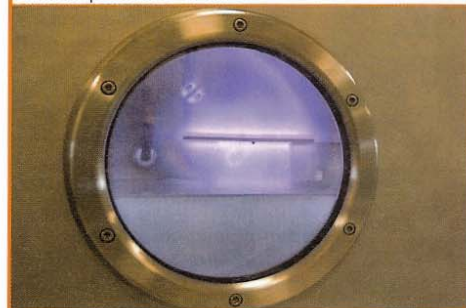
Plasma cleans and creates sterile surfaces. Gas mixtures can be tailored to provide cleaning by sputtering or reactive-ion etching and enhanced sterilisation by promoting ultraviolet radiation. The level of energies in the thin layers depends on the magnitude of the electric field. By varying the frequency and strength of the field, that is, by applying a DC bias, the speed of particles in the plasma approaching the surface can be controlled. This in turn modifies the speed and intensity of mechanical, physical or chemical reactions at the surface of the workpiece for the removal of surface contaminants without damage to delicate substrates.

Using plasma to change the surface properties of polymers, metals, ceramics or composites is straightforward. Plasma technology allows a thin layer of high-energy ions to be held at the surface of the workpiece. Because the plasma is formed within an electric field, the plasma forms on all surfaces that hold the charge.

Figure 1: Loading a plasma processing system with polymer components.



Figure 2: Plasma treatments operate in high vacuum but at room temperatures below 100 °C.



Other technologies tend to use methods that require a line of sight from an injection point to a surface. Flat surfaces, enclosures, bores, extremely concave shapes such as the inside of tubes, screw sockets, thin bores, woven textiles, fibres and other complex geometries are all treated efficiently.

Plasma can be utilised to clean, functionalise or "cold" polymerise coatings with a range of surface properties. Surfaces containing carbonyl or carboxyl carbon compounds can be processed to take up all the potential for new reactions or to leave varying degrees of potential for later reactions to produce a virtually inert surface or a highly reactive surface to promote adhesion or bonding. This means that a tailored surface can be produced for specific applications.

Processing and applications

Plasma process management is critical. To achieve optimum conditions, the vacuum chamber has to be closely monitored and depending on the actual task there are stringent conditions to be met in terms

of voltage and control of magnetic or electrostatic fields. The latest plasma processing units provide automatic, verifiable logging and tracking of every aspect of treatment, including designated operator interaction, if required. Systems track parameters and users batch by batch.

Plasma's ability to produce high levels of guaranteed sterility opens up new opportunities for bioengineering with plastics and other materials that melt at low temperatures or cannot withstand the autoclaves and the aggressive chemical environments of ethylene or gamma irradiation. Plasma processing is suitable for a range of medical devices:

- Polymer and composite surfaces used in prostheses such as knee and hip joints.
- Delicate fabrics such as wicks to draw blood or other body fluids into sensors, for example, blood glucose sensors.
- Wound-care materials such as medical gauze.
- Drug-delivery systems such as inhalers and other items such as stents for cardiac care and fabric stents used to repair

aneurysms can be made more biocompatible or safely enhanced to meet desired performance levels.

Plasma technologies now provide practical and well-understood processes that pave the way for new advances in biocompatible surface treatments for polymers, ceramics and metals.