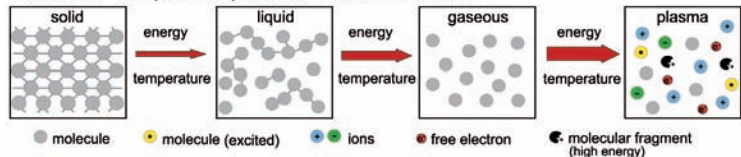


Basics of the plasma process: States of matter



Plasma technology does not stop at the gaseous state of matter. By using an electronic discharge to feed additional energy into the material the electrons are given more kinetic energy and they leave their atomic shells

Plasma: the fourth state of matter

PLASMA is the name given to matter at a high, unstable energy level. Energy, in the form of heat, added to a material takes it through the states of solid to liquid to gaseous. Plasma technology does not stop at gaseous: additional energy from an electric discharge fed into the material, adds kinetic energy to the electrons, causing them to leave their atomic shells. Free electrons, ions and molecular fragments are produced which can be harnessed to modify the surface of a material with which they come into contact. This is plasma.

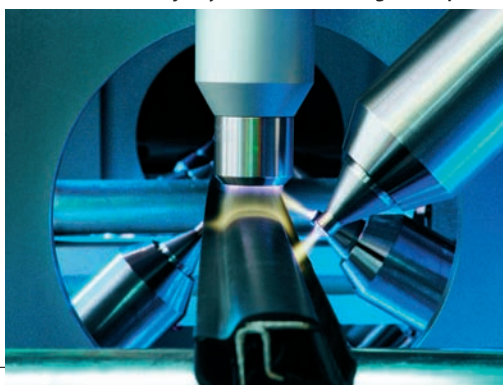
But the process is hard to use at normal pressure because of its instability, so has to be carried out under vacuum, which works against it as an industrial application. The patented Openair atmospheric pressure plasma, however, enables jets of plasma to be used in production processes, some of them in-line.

The systems are based on a jet principle, with an electric arc ignited in the jet generating a plasma from the working gas – air. The plasma has a zero electrical potential and flows to the product to be treated. It contains particles which are sufficiently excited to initiate selective oxidation processes on the surface of the product.

A particular characteristic of the emerging beam of plasma is its electrical neutrality which greatly extends and simplifies its range of uses.

Depending on the power supplied and the configuration of the plasma source the temperature of the emergent plasma can reach up to 300 degC and allows very high treatment speeds so that typical increases in temperature on plastic surfaces during treatment are less than 20 degC.

Flexible jet system for activating EPDM profiles.



Plasma treatment to improve adhesion on a surface involves destroying a gas – normally air – with a high electric charge and spraying its molecular detritus on to the surface. This alarming-sounding operation once had to be kept under control in a vacuum enclosure, but there is now a technique for plasma treating in the open air with a device akin to a blow torch. Dipl Ing Christian Buske and Dr Alexander Knospe of Plasmatreat describe their company's Openair plasma process.

The plasma modifies the plastic surface to achieve three functions:

- activation – the production of functional groups to facilitate the bonding of adhesives and coatings;
- cleaning – removing mould release agents and additives; and
- coating to apply protective and barrier layers.

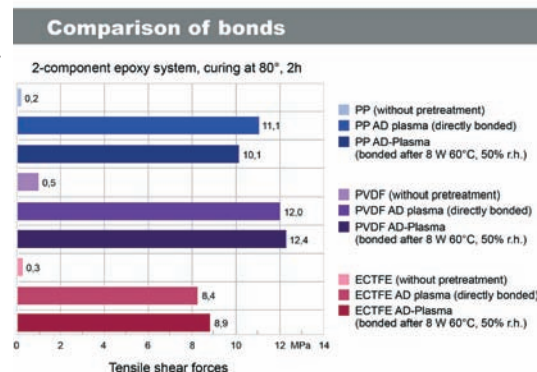
Activation

Activation of the surface is a pre-treatment process which has uses from high-technology adhesive bonding to simple labelling or glueing and enables the equal use of modern solvent-free UV adhesives and natural, water-based systems. For example, after pre-treatment with Openair Plasma, polycarbonate windows can be glued into the housing half shells of mobile telephones using solvent-free UV adhesives. The process, however, can equally well be used with casein adhesives when labelling plastic drums.

Non-polar materials such as polypropylene or partially-fluorinated plastics are very difficult to bond without pre-treatment. However, after activation by Openair Plasma the tensile shear strength of the material rises by a factor of about 50. Even after storage for 8 weeks prior to bonding the tensile shear strength changes only slightly, so that under those conditions the treatment remains stable over a long period.

Atmospheric pressure plasma has been used to pre-treat polypropylene films to ensure that they accept print well and can also be bonded. For years, alongside flame treatment, films have been corona-treated which has enabled films of great width to

Tensile shear forces of plastics bonds with and without pretreatment



be pre-treated at medium to high speeds. There is a risk with corona, however, of double-sided pre-treatment which can cause jamming of the film on the roll. The zero potential of atmospheric pressure plasma guarantees one-sided pre-treatment while surface effects remain high. Corona pre-treatment also gives only moderate to poor activation. The effects achieved are not very stable and dwindle rapidly in storage. Pre-treatment with atmospheric plasma achieves surface energies which even allow printing on plastics with water-based surface coating systems.

Cleaning

The plasma process can selectively peel away layers at atmospheric pressure in a continuous industrial process, providing cleaning effects which surpass those of conventional systems.

Here the high electrostatic discharge effect of a free beam of plasma is further enhanced by the very high speed at which the plasma streams out to strip away loosely adhering particles. For instance Plasmatreat has improved the removal of mould release agents from PU moulded parts like profile sections for furniture or air bag covers. Other in-line uses for Openair Plasma have been the removal of organic layers, stripping varnish, and the partial removal of metallised coatings prior to bonding.

Coating

Coating by plasma used only to be possible under vacuum. But it is now possible at atmospheric pressure with Openair technology combined with a new method for feeding in precursor material. The precursor is a vaporizable reactive material which, after the treatment, remains on the plastic as a coating.

One application newly developed by Plasmatreat is the selective deposition of water vapour barriers on CD blanks. Apart from its technical advantages, the process also brings material cost savings since now polycarbonates can be used instead of expensive cyclo-olefins.

Plasmatreat is based in Steinhagen in Germany, but also has a British office in Bicester.

www.plasmatreat.co.uk

Factfinder 105

Environmentally friendly pretreatment of a mobile telephone housing using a rotating plasma generator.

