Adapted version from the German original: JOT 4. 2007

Plasma Pretreatment

From Perfume Bottle to Speedometer Display

The list of items could be extended endlessly. Pretreatment with atmospheric pressure plasma is arousing ever more interest among users who require microscopically fine precleaning and high activation of surfaces prior to the painting process.

Whether it's a light switch or mobile phone housing, display or perfume bottle – manufacturers are putting ever more effort into improving their surface coating processes. This also requires action to optimise pretreatment. Pretreatment processes range from ionization or flame treatment through wet chemical processes, power washing and use of primers right up to dusting with ostrich feathers.

Thorough pretreatment is decisive for immaculate surfaces in automotive engineering

Despite the sometimes high investments made, the proportion of reject parts in production caused by painting over particles of dust is often well above 10 %. Static charging of surfaces, tiny but still unacceptable remnants of fine dust in less accessible areas or environmental pollution are the most common problems in the aforementioned processes.

Plasma, the fourth state of matter

Plasmatreat has developed a process for plasma pretreatment (Openair plasma) whose use eliminates the problems identified above and hence drives down the proportion of rejects. Plasma pretreatment brings about microscopically fine cleaning and high activation of the most varied surfaces and hence promotes optimum adhesion of paints and adhesives. Moreover, plasma cleaning is more economical than conventional pretreatment methods while at the same time being very environmentally friendly.

An atmospheric pressure plasma is generated inside the plasma jet by means of high-voltage discharge

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Plasma is the name given to matter at a high, unstable energy level. When energy is supplied to matter changes in state occur: a solid becomes a liquid and a liquid becomes a gas. If further energy is then supplied to a gas it becomes ionised and changes into the plasma state representing a further state of matter. On contact with the surfaces of materials the supplied energy is transferred to them and is available for subsequent reactions.

The mobile phone housing is cleaned by a rotating plasma jet prior to painting

If additional energy can be fed into the material by means of electric discharge the electrons gain more kinetic energy and leave their atomic shells. Free electrons, ions and molecular fragments are produced. This state, however, can scarcely be used at normal pressure because of its instability.

Only the atmospheric pressure "Openair" plasma process developed by Plasmatreat opened up new possibilities: by developing and employing plasma jets this state of matter, scarcely used hitherto in industry, has now been successfully used for the first time in production processes, even in-line.

Electrically neutral plasma beam

The systems based on a jet principle operate at atmospheric pressure and with the aid of an electric arc ignited in the jet and the working gas, air, produce a plasma which flows at zero potential onto the surface of the product to be treated. It contains enough excited particles to produce selective effects on the surface.

A particular characteristic of the emergent beam of plasma is that it is electrically neutral, which greatly extends and simplifies opportunities for use. Its density is so high that operating speeds of 100 m/min are achievable. Heating of plastic surfaces during treatment typically amounts in this case to $\Delta T < 20$ °C.

In the process the surface is activated and adhesion is significantly improved. Due to the process of discharging on surfaces the plasma system affords cleaning effects which are superior to those of conventional systems. The decisive factor in this is the electrostatic discharge action of a free beam of plasma. This effect is reinforced by the high outflow rate of the plasma as a result of which loosely adhering particles are removed from the surface.

The “Openair” system is characterised by a threefold effect. It activates the surface by selective oxidation processes, simultaneously discharges the surface and due to high-speed air currents cleans off loosely adhering particles.

The jet systems employed can be integrated in-line into any new or existing production line. Some examples of applications are described below.

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Mobile phone housings

The highest demands are imposed on the surfaces of mobile phone housings. The paint finish must be free of defects and its overall appearance must not be impaired by imperfections. Electrostatic adhesion of dust and particles transferred from the injection mould are the principal causes of this.

Suppliers to the mobile phone industry in South Korea and Finland have already responded positively. Here Plasmatreat installed units for cleaning mobile phone housings. These provide extremely efficient cleaning in in-line processes. Immediately prior to painting, several rotating plasma generators very efficiently clean the plastic surfaces. The users were able to reduce the proportion of rejects from 12 % to less than 5 %.

Vehicle parts

For two years a vehicle manufacturer has been using Openair plasma for pretreating plastic surfaces. The high demand for vehicles having expensive multiple layers of paint caused bottlenecks in the curing ovens.

Pretreatment with plasma is also used in the painting of headlight lenses

A vehicle part usually passes through many stations during the painting process. A typical plastic part is given a coat of primer-adhesion promoter, up to eight coats of paint plus a clear coat. But ovens have limited capacity. Most manufacturers have only one paint line and one curing oven per factory. Thus, one part will travel though the same oven from four up to nine times. Any way a manufacturer can increase capacity without cost-intensive procurement of new equipment results in significant cost savings.

After injection moulding and prior to painting, cockpit module housings are thoroughly cleaned with plasma

In the present example it is not possible to retain the same high-quality appearance of surfaces while reducing the number of finishing coatings used. However, with the aid of the plasma treatment it was possible to dispense with the primer coating promoting adhesion. In this way the number of passes through the oven were reduced by 25% or conversely the capacity of the oven

was significantly increased. In addition it was possible to eliminate the entire priming process and the high costs associated with it.

Automobile interiors

Switches with laser-etched symbols, high-gloss decorative strips and covers, scratch-resistant displays and glittering fascias, ventilator grilles or glove compartments – even plastic parts in the interiors of automobiles are today provided with expensive coats of paint.

Here plasma technology can be used as a pretreatment process for these components both prior to bonding as well as prior to painting. Accordingly, to cite some examples, the process is used for vehicle parts made by BMW and Rolls Royce.

Perfume bottles

Pretreatment with atmospheric pressure plasma, however, is not just an issue for materials such as plastics or metals. It is also relevant to glass surfaces. Thus, the glass bottles for expensive perfumes are often painted, some even in multiple colours. The high-quality image of the bottles demands an immaculate surface and the most thorough cleaning of the material prior to the painting process. A German perfume bottle manufacturer is also profiting from the advantages afforded by plasma technology. It has been running a plasma pretreatment installation since last year. **Inès Melamies**