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[TECHNICS]

Plasma surface technology: Joins metal to plastic

# Components from one casting

Complicated fittings for use in heart-lung machines comprising metal inserts encapsulated in polycarbonate can be produced at low cost by the use of atmospheric-pressure plasma.

For a long time now moulds have been coated by means of plasma technology in order to extend their service lives. The technology is also used for cleaning processes. "The energy in a plasma beam is usually high enough to break the binding energy levels in molecules so that they can make new bonds with the gases in the immediate environment", explains Christian Buske, Managing Partner of Plasmatrete GmbH, Steinhagen. After all, the states of matter are changed by supplying energy. A solid turns into a liquid and the liquid becomes gaseous. If further energy is now supplied to a gas it ionises and passes over into the plasma state which is a further state of matter. Industrial plasma surface technology makes use of this process.

Today, as a rule, plasma processes take place in vacuum. This has the disadvantage that relatively expensive vacuum pumps and chambers are needed to

generate and maintain the required low pressure. Furthermore, the coating



The zero-potential pulsed plasma beam brings about microfine cleaning of the metal insert prior to injection moulding (above). This metal insert which measures the temperature of the blood during an operation is inserted into the mould and encapsulated in polycarbonate. As a result of the precleaning an absolutely airtight joint between the metal and polycarbonate is ensured. Photos: Gira

chambers usually cannot be easily integrated into existing production lines.

In the case of atmospheric-pressure plasma, on the other hand, it is possible to integrate the required jets in-line into new and already existing installations. In this way Plasmatrete has developed what is referred to as the Openair process in which the plasma is applied to the surface of the material by means of special jets fed only with air, or if need be a process gas, and with high voltage. Depending on the



geometry of the jet the emerging plasma is available over a working width of up to 25 mm or at a treatment spacing of 40 mm.

"The emergent plasma beam is electrically neutral. This greatly extends and simplifies the range of applications" says Buske. Its intensity is so high that treatment speeds of several 100 m/min are achievable.

Accordingly, the supplier's system can be employed in three areas: it activates a surface by selective oxidation processes, discharges the surface at the same time and brings about microfine cleaning.

## Your Keyword

- Atmospheric-pressure plasma
- Combined injection moulding and plasma technology
- Joining metals and plastics
- Absolutely airtight joint

By adding a process gas it can additionally be used for providing surfaces with a nanocoating. In this way pretreatment with atmospheric-pressure plasma allows the joining of materials that in principle are incompatible, such as metal and plastic. For this purpose the Plastics Technology Division of Gira Giersiepen GmbH & Co. KG, Radevormwald, employs, for example, a combination of injection moulding and Openair plasma technology in order reliably to manufacture at low cost complicated fittings for use in oxygenators. These are parts that are adapted to the oxygenator, an important constituent of a heart-lung machine. Located within this workpiece is a metal insert which constantly measures the temperature of the blood during an operation.

To avoid external assembly the metal insert is inserted into the mould and encapsulated in PC. "Pretreatment with atmospheric-pressure plasma is for us the only method possible for ensuring the absolute airtightness of the joint between the metal and polycarbonate" declares Dirk Brongkoll, Key Account Manager at Gira in the business sector of Plastics Technology for Medical and Pharmaceutical Technology. "The use of adhesion-modified compounds or an additional adhesion promoter layer would not be economical and scarcely validate process safety."

In the Gira clean room (class 10 000) not only is the entire volume of air exchanged 80 times per hour, but also additional filters and laminar flow modules over the handling and mould area of the externally connected injection moulding machine must guarantee a constantly high quality of air during the entire production process. The fact

that the Openair plasma jets were integrated in-line in the production line meets this requirement.

For manufacturing the component to be connected to the oxygenator at Gira the metal parts are placed individually in a spiral conveyor then picked up from the collection position by means of a handling system and deposited in the plasma treatment station. The pulsed plasma beam activates and cleans the rotating workpieces over their entire surface before the inserts are placed into the mould by the



Production in Gira's clean room. Additional filters and laminar flow modules over the handling and mould area of the externally connected injection moulding machine ensure an unchanging quality of air during the entire production process.

## Material costs can be saved

Plasmatreteat in collaboration with the Chair of Plastics Technology at the University of Erlangen and the companies Neue Materialien Fürth and KraussMaffei has been working for some years on the issue of increasing the compatibility of different rigid and flexible materials in the injection moulding process. The results are that low-cost polypropylene (PP) and thermoplastic polyurethane elastomers (TPU), for example, no longer fall apart in injection moulding when the PP surface is first treated with plasma. "In this way it is possible in many applications to dispense with ABS-PC and so save approximately one third of the material costs" says Plasmatreteat Managing Director Christian Buske. Furthermore, by this means several production steps are carried out in one injection moulding machine. The atmospheric-pressure plasma assumes the task of cleaning and activating individual elements of the components in-line in such a way that not only a dependable joint is ensured, but also that the additional assembly steps otherwise needed are rendered unnecessary. Multicomponent injection moulding is a production process which allows different materials to be combined with one another in one system. The aim of the combined process is to join as many individual parts as possible to one another in one cycle. To ensure that the different materials and parts adhere precisely to one another they are pretreated by plasma.



handling system and at the same time the finished components are withdrawn from the cavity. Here plasma is employed as a complete in-line solution for cleaning and activating the surface. The insert is not altered either in terms of its surface structure or in its technological properties.

Atmospheric-pressure plasma operates directly on the surface and ensures that the melt wets the metal surface. Organic contaminants are oxidised away and as a result the surface tension is increased to a value  $> 72$  mN/m. Integrated process monitoring ensures that this step in the process is carried out reliably. By applying the plasma process Gira is able to manufacture the hybrid components not from several parts but as a single component in the injection moulding machine.

- Sabine Koll  
Journalist in Böblingen

**» Further Information**

[www.plasmatreat.de](http://www.plasmatreat.de)

[www.kunststofftechnik.gira.de](http://www.kunststofftechnik.gira.de)