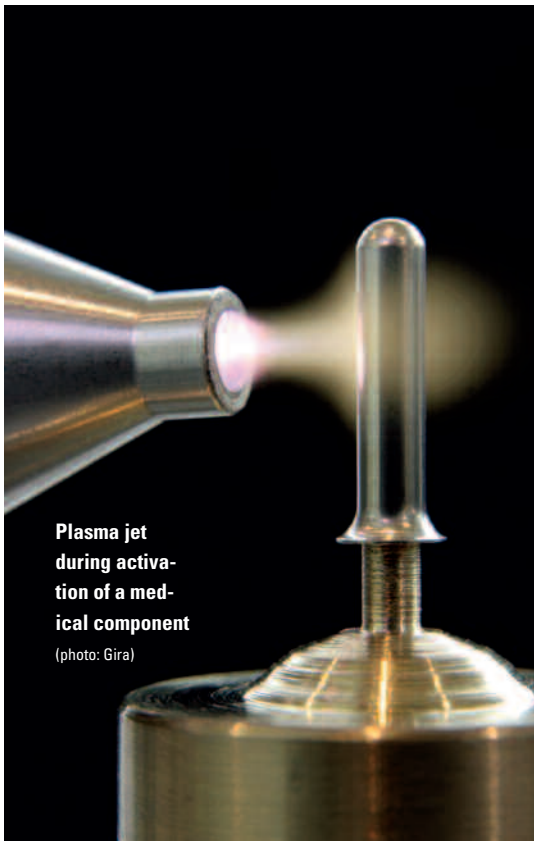

Plasma jet during activation of a medical component (photo: Gira)

Sandwich Moulded Components. Ever more frequently in the production of complex components the most varied materials are combined. Metals, glass and ceramics must form durable and impermeable bonds with the plastic. In order that the different materials and parts adhere to one another with maximum precision they are pretreated with a plasma.

Atmospheric In-line Plasma in Medical Technology

JOACHIM SCHÜSSLER
CHRISTIAN BUSKE

Production by the sandwich moulding process allows the most varied materials to be combined with one another. By means of rigid-flexible composites it is possible, for example, to provide housing components with a seal, to back inject decorative films with a backing material or to produce hybrid parts (metal-plastic composites). The objective is to combine as many different parts as possible in one and the same cycle. In this way the number of assembly steps can be reduced and process reliability increased. In order that the different materials and parts adhere to one another with maximum precision they are pretreated with a plasma (Fig. 1).

Production with Plasma Treatment

Sandwich moulding in combination with atmospheric pressure plasma technology

Translated from Kunststoffe 8/2006, pp. 72–74

IR photograph of a surface cleaned by plasma

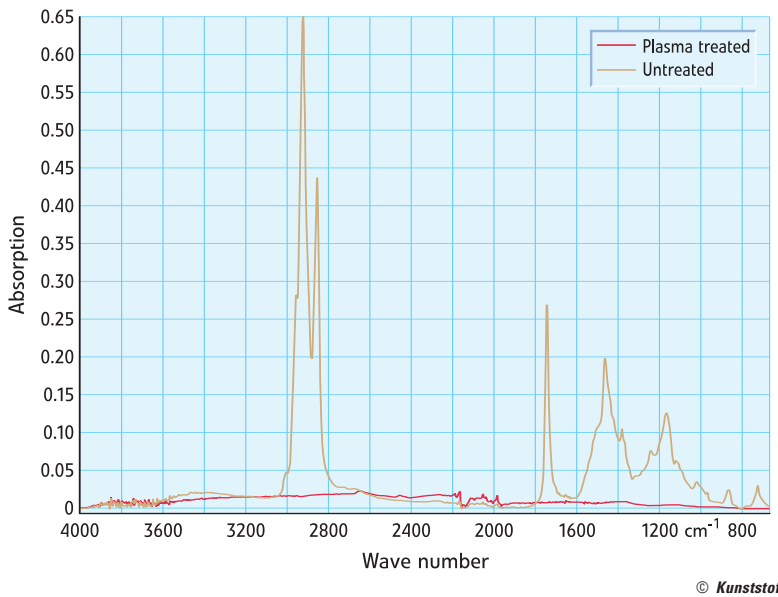

Fig. 1. In the secondary cleaning of inserts prior to encapsulation by injection moulding Openair Plasma removes all organic contaminants, such as fats and oils, as well as water adhering to the boundary layer (source: Plasmatreat)

from the plant developer, Plasmatreat, Steinhagen/Germany, not only opens up new opportunities in composites but also distinctly increases the level of achievable adhesion. The plasma does the job of cleaning and activating individual elements of the components in-line in such a way that not only a more reliable composite is ensured, but also the assembly steps otherwise needed can be dispensed with.

The target technologies for plasma treatment are two-component injection moulding together with associated upstream and downstream processes. Due to pre-treatment with plasma it is possible not only to join otherwise incompatible materials but also to optimise process reliability and increase quality.

Integral composites can now be achieved with combinations which hitherto exhibited only little or no adhesion.

The effects of certain processing parameters on adhesion are diminished and even standard materials can be more effectively joined to one another.

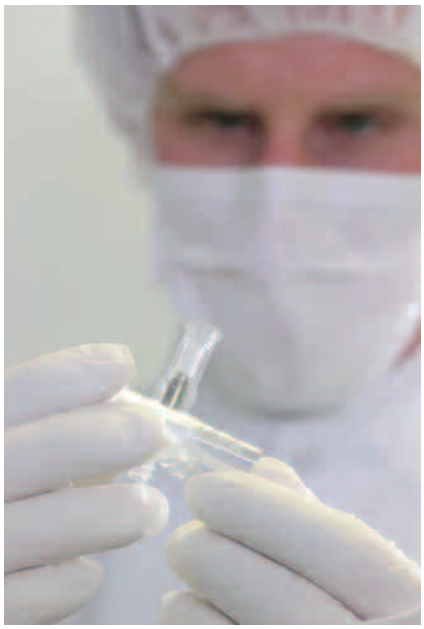

Fig. 3. The components are checked in the clean room under high safety precautions (photo: Gira)

Fig. 4. High requirements in medical technology: The entire volume of air in the clean room is exchanged completely 80 times per hour (photo: Gira)

In the process presented an atmospheric pressure plasma is applied to the surface of the material by special plasma jets. In the „Openair Plasma" process developed and patented by Plasmatreat the jets are operated with air or even a process gas as well as with high voltage. Depending on the geometry of the jets the emerging plasma is available over a working width of up to 50 mm with a treatment gap of 40 mm.

The plasma beam produced is electrically neutral which greatly extends and simplifies the application. The temperature of the plasma depends on the power input and structural form of the plasma source and can be up to 300 °C. This allows very high machining speeds with optimum effects (Fig. 2).

Use in Medical Technology

In recent years numerous Openair Plasma applications have opened up in medical technology:

During heart surgery a heart-lung machine temporarily takes over the function of these vital organs. The uptake of oxygen by the blood ensues via membranes whose quality decides over life and death. The use of Openair Plasma has for some years now enabled the reliable production and perfect fitting of such membranes.

Aseptic conditions are a key requirement in medicine (Fig. 3). Medicines and instruments must be packaged to the highest quality so that they are absolutely germ-free. If the plasma is applied to the packaging material at the correct intensity germs are killed off without at the same time altering the nature of the starting material.

In the provision of implants with wear-resistant coatings or with biocompatible coatings which allow ready growth of tissue, plasma polymerised coatings have already proved to be effective. Plasmatreat is playing a pioneering role in this field with atmospheric coating solutions.

The pre-treatment of tubes and cannulae prior to bonding and gating is another application of plasma treatment in

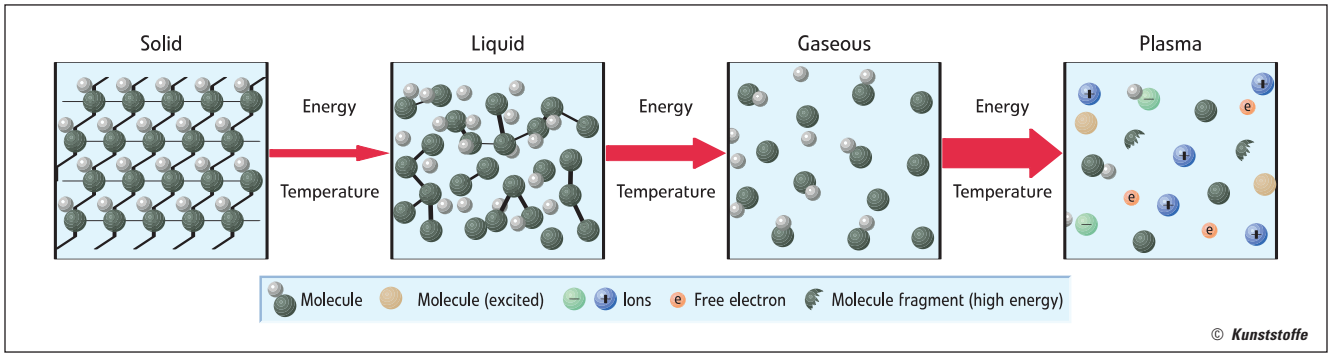

Fig. 2 Fundamentals of the plasma process: plasma as the fourth state of matter (source: Plasmatreat)

medicine, as is the improvement of the interlaminar bonding of TPU membranes for injection septums. Another process developed by Plasmatreat under the name of PlasmaPlus is used for coating plastics in atmospheric plasma with functional and vitreous layers. This alters the permeation properties of plastics and in this way increases the service life of medicinal packaging units.

Example from Practice

Gira, Radevormwald/Germany, a company well known for its household and switch technology expanded its Plastics Technology Division some years ago into the field of medical technology. Given the company's in-house production of plastic parts, system products and moulds as well as the establishment of a medical clean room in accordance with ISO class 7 this manufacturer possesses every qualification for this high-performance sector. The company today uses a combination of injection moulding with Openair Plasma technology to produce dependably and at low cost complicated fittings for use on oxygenators.

The oxygenator to which the component is fitted is one of the most important elements in the heart-lung machine. Inside the fittings there is a metal insert which during an operation constantly measures the temperature of the blood. The metal insert is placed in the mould as an insert part and encapsulated by injection moulding with polycarbonate so that external assembly is avoided. The bonding between the metal and the polycarbonate must be absolutely impermeable. Extensive tests have shown that pretreatment with atmospheric pressure plasma is the sole process here by which this requirement is fulfilled. The use of adhesion-modified compounds or an additional bonding agent layer is not permitted by medical guidelines.

Production in a Clean Room

Gira's clean room fulfils the requirements of class 10.000. The entire volume of air is exchanged 80 times per hour (Fig. 4). Additional filters and laminar flow modules over the handling and mould area of the injection moulding machine connected from the outside guarantee a constant level of air quality during production.

In particular, given the high clean room specifications it is advantageous that the Openair Plasma jets can be integrated into the production lines. Accordingly, no additional plant components are required.

To produce the component to be joined to the oxygenator the metal parts in a spiral conveyor are picked up singly from the collecting point by means of a handling system and deposited in the plasma treatment station. The pulsed plasma beam (approx. 2 s intervals) activates and cleans the rotating workpieces over their entire surface area before the inserts are placed in the mould by the handling system and at the same time the finished components are taken out of the cavity (Fig. 5). The plasma is used here as a completely in-line solution for cleaning and activating surfaces. An inserted part is neither changed in its surface structure nor in its technological properties.

The atmospheric plasma operates directly on the surface and ensures that the melt wets the metal surface. Organic impurities are oxidised away. As a result the surface tension increases to > 72 mN/m. The integrated monitoring system ensures that this step in the process proceeds correctly and without errors. As the sole manufacturer worldwide, Gira is able to use the Openair Plasma process to produce these hybrid components as single parts in the injection moulding machine and not from a number of different parts. ■

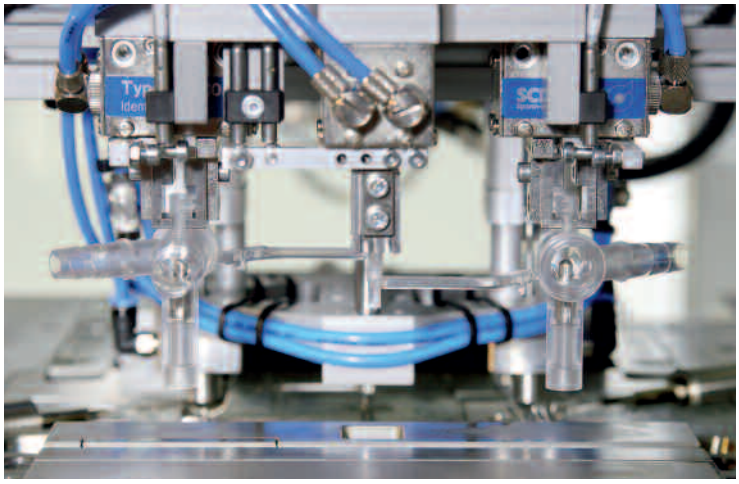

Fig. 5. The finished components with the encapsulated metal insert are removed in pairs from the mould cavity (photo: Gira)

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