(bri) Adapted version from the German original: ADHÄSION 4 / 2007

IN-LINE CASTING WITH INTEGRATED PLASMA TREATMENT

Secure protection for electronic components

In order for electronic components to be capable of withstanding particularly adverse environmental effects they must be perfectly casted. In connection with this it is important that there is excellent adhesion of the casting material to the surfaces of the components. A novel in-line solution now promises flawless processing. This involves fully automated casting installations being equipped with an atmospheric pressure plasma unit for pretreating the component housings. This unit provides microscopically fine precleaning and activation of the surfaces of the workpieces.

Nowadays electronics is employed in a vast range of applications. Both professional and private life can scarcely be imagined without this branch of technology. End users naturally expect troublefree operation and reliability. Individual extreme influencing factors such as vibrations, dust, pressure, moisture or heat which act remorselessly on the ever smaller and more powerful components are just not noticed by consumers. The product simply has to function come what may.

Protection by casting

In order to protect electronic components under such harsh and variable operating conditions and to ensure a long service life the components are casted by means of suitable materials, that is to say they are protected against environmental effects by sealing them. In doing this it is important to devise the casting process so that there are no weaknesses. This means primarily that there must be no air occlusions, cracks or irregularities in the casting.

Photo: Plasmatreat
The pretreatment and activation of the surfaces of housings prior to application of adhesive by Openair plasma brings about optimum imperviousness of the electronics

Successful casting, however, depends not only on the casting material or the casting installation, but also on the surface of the component on which the material is to be casted. There are various reasons for the adhesion between the casting material and the surface of the workpiece (housing) being too "weak". For example, traces of grease or dust can often be found or the physical and chemical conditions may be so unsuitable that they prevent ideal contact between the surface and the casting material. Marked variations in temperature or vibrations then result in detachment at some points or the formation of gaps at the edge of the casting material. Moisture or corrosive media can penetrate through these openings and impair or even destroy the functions of the component.

Photo: Scheugenpflug
Figure 1 Atmospheric pressure plasma treatment has now long been used as an easily operable in-line method in automated processes

Plasma pretreatment

Atmospheric pressure plasma treatment is recommended as the method of choice for reliably ruling out this problem. This method has been refined to such an extent that it has now long been used as an easily operable in-line method in automated processes (see Figure 1). The principle is that a plasma is generated from ordinary air by an electric discharge. That is to say so much energy is pumped into the air that the molecules split apart and form ions and electrons. This plasma, which depending on the conditions of its production has a temperature of between 100 ºC and 300 ºC, is conveyed through a jet to the workpiece after it has been converted to the same electric potential as the workpiece to be treated (see Figure 2). In this way the operation is guaranteed to proceed without flow of current in the treated workpiece. Thus, the functional capability of electronic components is in no way impaired by the plasma treatment. Heating effects can also be adapted in optimum fashion to the application by appropriate settings for the process parameters. When treating electronic components heating can be kept to below 20 ºC. The high-energy ions striking the surface of the workpiece at almost the speed of sound bring about two effects. On the one hand, they break down organic matter adhering in minimum amounts – such as fingerprints – into small molecules which are dawn off as gas in the extraction system. In this way the surface is cleansed of minute clinging deposits, literally to the depths of its pores. Thus, the risk of dirt forming a partitioning layer between the casting material and the workpiece is completely averted.

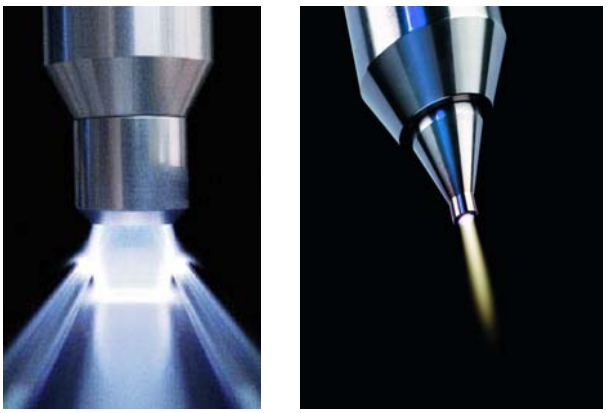

Figure 2 The electrically neutral Openair plasma beam allows microscopically fine cleaning, high activation and paper-thin coating of surfaces

Photo: Plasmatreat

The second effect consists in activating the surface. The ionised air forming the plasma is composed to a large extent of extremely reactive oxygen ions and radicals. These particles react at the surface with the plastic and the workpiece and alter them both physically and chemically. On the one hand, they increase the surface tension to such an extent that the casting material flows into each tiny cavity on the surface of the workpiece. On the other hand, the surface becomes highly reactive so that firm chemical bonds can be established between it and the hardening casting material. Both effects together ensure an intimate joint between the casting material and the housing so that the bonding between these two different materials is just as great as the cohesion within the casting material itself.

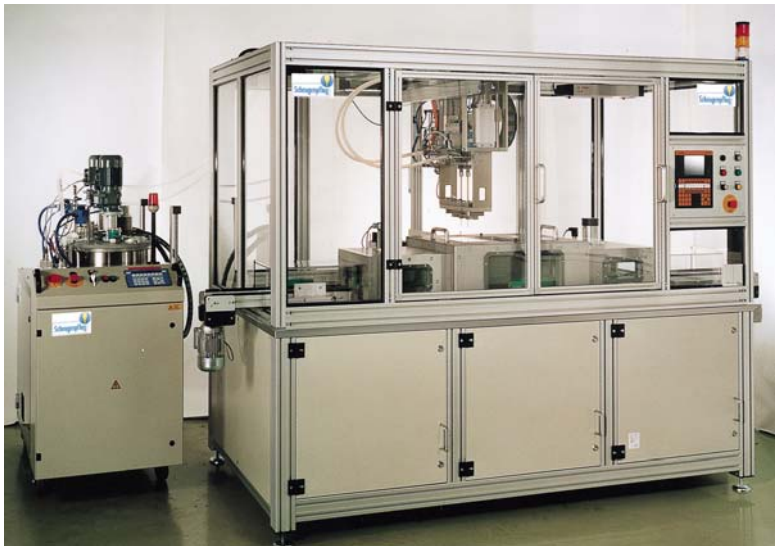

Photo: Scheugenpflug
Figure 3 In-line vacuum chamber extendable for all production steps before and after casting.

Plasma treatment immediately prior to casting

The plasma treatment must be carried out in the production line immediately prior to casting in order to avoid recontamination. It is obvious that any intervention by human hand in this production step may result in soiling which in turn would weaken bonding. To obviate any unnecessary risk it is further recommended that the plasma treatment be directly linked to the subsequent casting, e.g. by automation. If the plasma jet is integrated into a portal system permitting movement in all three spatial directions it is possible by means of suitable programming to treat uneven surfaces of any shape without leaving gaps (see Figures 3 and 4). This has been implemented in a unit schematically illustrated in Figure 5. The entire process is controlled from the casting unit with corresponding signals being transmitted to the control system of the plasma unit. The sequence of movements of the plasma jet and that of the feed head are identical. In this way the path traversed by the feed head need be programmed only once and can be

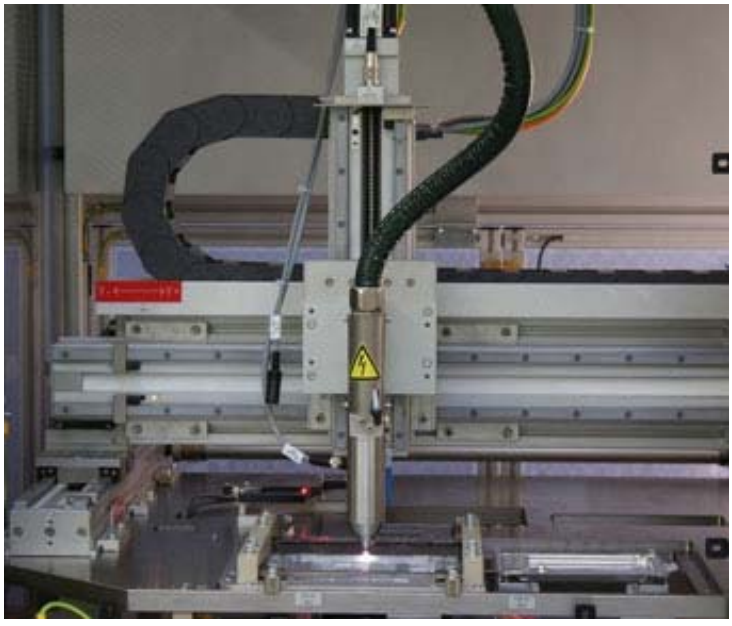

Photo: Scheugenpflug
Figure 4 View of the axial system of a plasma pretreatment system

taken over point by point for the plasma jet. In a fully automated installation the tool support is carried directly into the into the casting chamber. There, depending on requirements, the components can be encapsulated in vacuo (to prevent air bubbles in the resins) or at atmospheric pressure. After application of the beads of resin or filling the components the tool supports can be transported seamlessly into a curing chamber.
There are various methods for curing, including UV and infrared irradiation or simple curing ovens.
Companies that decide in favour of plasma pretreatment prior to casting should take care that the interfaces are 100 % compatible. It is even better to procure the plasma and feed units from one system supplier so that on start-up a perfectly tuned and seamless process flow can be guaranteed.

Photo: Scheugenpflug
Figure 5 Graphic illustration of an in-line casting installation with integrated plasma pretreatment

Conclusion

Pretreatment with atmospheric pressure plasma is a milestone in casting technology. By means of this method of treatment the adhesive properties of the surfaces of components can be optimised to a degree that is unattainable by any other method. Given appropriate casting conditions this pretreatment method can further increase the quality of casting and thus significantly extend service life.

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