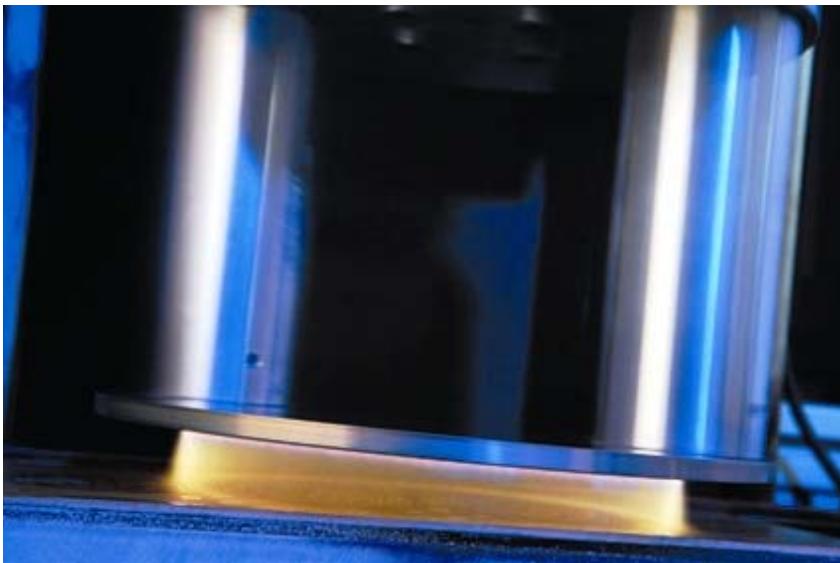




# Atmospheric Plasma sets standards in the coating process of circuit boards

**Circuit boards of potentiometric position transducers and rotary sensors are imprinted in a screen printing process with a conductive ink. In the production of a South-German manufacturer, the use of atmospheric plasma for the boards' pretreatment led to impressive results.**



**Fig.1. The rotation jet has two atmospheric plasma sources for inline cleaning and neutralization of the circuit board while activating the material surface so strongly that it becomes receptive to coating, printing or adhesive bonding processes. Photo Plasmatreat**

Countless automation processes are later depending on the durable adhesion of the conductive ink. Therefore an effective pretreatment of the substrate to be printed on, i.e. the cleaning and activation of its surface, is a mandatory measure. Various methods are available here. One of the still frequently ones is the pretreatment with solvent based chemicals. This method, however, is detrimental to the environment and often associated with high waste disposal costs.

At Novotechnik, a German manufacturer of high-grade potentiometric and non-

contacting position transducers and rotary sensors, environmentally-friendly production started as early as in the 90ies when the pre-treatment of circuit boards had been effected for a long time by means of low pressure plasma in a vacuum chamber. The process proved to be efficient. But as an enclosed system, it also bore its disadvantages for production: While vacuum chambers are perfectly suited for batch processes, they are less suited for the pretreatment of large quantities. The process times used to be too long. What's more: Integration into the existing

screen printing lines was not possible either. In addition the operation was very labor-intensive since one person had to equip the low-pressure chamber first before taking out the components manually thereafter.

Having decided to increase production from the year 2000 onward, the company looked into an alternative process – and made a discovery. The solution was again a plasma process but this time without the above limitations (Fig.1).

## Atmospheric Plasma

The atmospheric pressure Openair plasma process, developed by the Westphalian manufacturer Plasmatreat already in 1995, is based on a nozzle principle for the most varied component geometries. Unlike the complex plasma low-pressure systems the plant is now integrated into the production line for continuous processing and operates under completely normal atmospheric conditions. The jets are driven solely by air and by high voltage. The potential free plasma system is characterized by a threefold action: It activates the surface by selective oxidation processes, simultaneously discharges the former and brings about microfine cleaning of the surfaces.

## Activation

The pretreatment of the printed circuit board surfaces primarily deals with their activation, i.e. the increase in surface energy. It is the most important measure for evaluating the probable adhesive strength of an adhesive layer or



**Fig.2. Complete throttle valve with flap, integrated actuator and sensor. Pretreatment with Openair Plasma is effected before the integrated sensor circuit board is coated. Photo Novotechnik**

coating. Plasma treatment, i.e. a strong activation of the material surface, can bring about a distinct increase in surface energy. Trials at Plasmatreteat have revealed that values up to over 72 mJ/m<sup>2</sup> become possible for most plastic materials. The result: Not only previously incompatible substrates can be bonded but also adhesion of water-based adhesive or painting systems on very adhesive-resistant surfaces such as unpolar plastic becomes possible in most cases.

### Sensors

Novotechnik sensors are applied mainly in the automotive and engineering production. Leading-edge automotive technology without sensors is hardly conceivable nowadays. What counts here besides the sensor's high precision and reliability is its long operating time. Typical examples in the field of motor management are the detection of the throttle valve position (Fig. 2) and of the pedal position.

Electronic pedal value modules comprise a pedal lever housing, a rotary sensor and a mechanical system for simulating the traditional accelerator pedal



**Fig.3. The equipped panels are stoved and cured in the furnace after printing. The circuit boards, once separated, are subjected to a 100% visual and electrical inspection.**

**Photo Plasmatreteat**

feeling for the driver. The accelerator pedal sensor supplies the controller with the position of the accelerator pedal and influences the air/fuel mixture through the position of the throttle valve. All printed circuit boards of these sensors are produced by Novotechnik using the screen printing process in combination with a specifically developed, high-grade conductive ink.

### Under test

Novotechnik quickly realized the potential of the new plasma technology. "The system could be easily integrated into our process and the throughput increased by saving labor at the same time," reports Dr. Tobias Eckert, Head of the Potentiometer Technology Centre. The testing included surface activation, testing of the adhesion (cross-cut) as well as comprehensive "service life tests" for quality assurance. In the course of the latter, the load types and load cycles which the product could be exposed to in service are simulated by means of specific test devices.

A customer, for example, demanded evidence for a throttle

valve product that the component is capable of being operated at over 10 million cycles on the motor with no significant changes in its electrical properties. To rank this challenge correctly you should know that this number corresponds to a travelled distance of about 1 million kilometers. Moreover, production by Novotechnik is governed by the general rule that technical modifications may not be merely and simply introduced. It is only after the production and handing over of samples to the customer and their testing and release that technical innovations may be adopted.

### Circuit board production by means of atmospheric plasma

The Openair process was introduced by Novotechnik into production at the end of 2000 for the very first time. The manufacture of the FR4 circuit boards which are of glass fiber reinforced epoxy material used for electronic circuits as a standard, is performed in a clean room environment. Plasma treatment is necessary to ensure good wetting



of the substrate with the conductive paste, also called conductive ink, in the screen printing process on the one hand and to achieve good adhesion of the conductive ink on the substrate on the other. Positive and important side-effect: The plasma flowing onto the surface at almost ultrasonic speed furthermore removes particles adhering to the surface and neutralizes the electrostatic charge of the circuit board after unpacking.

The Openair process takes at most 1sec. for the activation of the panel, which may contain up to 70 circuit board blanks. Thereafter, the panels are transported to the printing plant where printing with conductive ink takes place by applying the screen printing process.

The conductive inks produced by Novotechnik are in-house developments tailored to the respective applications. "They are actually the heart of a potentiometer because it is the quality of the conductive ink that determines the lifetime of the sensor in operation," elaborates Dr. Eckert. Once the curing process in the furnace is complete, the components are separated (Fig. 3) and subjected to 100 % electrical and visual inspection on the computer.

## Conclusion

Novotechnik is extraordinarily pleased with the results of the plasma treatment. Eckert: "I can declare the change from the low-pressure plasma chamber to the employment of the integrated Openair technology as a milestone in the development of our sensor production. By doing so, we have tripled the throughput. The process is highly efficient, safe, fast and therefore cost-effective. One plasma plant is enough for supplying several screen printing lines. The system works extremely reliably and

provides minimal susceptibility to failure so that high availability is ensured for the continuous production of our sensors." Since the introduction of the Openair plasma technology Novotechnik has produced and delivered far more than 50 million activated individual components. Up to the present time no adhesion problems with the coating have shown up.

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