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Plasma surface cleaning for a reliable wire bonding process

Openair-Plasma from Plasmamatreat GmbH is one of the leading technologies worldwide to activate and clean surfaces. It is used in numerous applications to pretreat different substrates. It can also be used to clean metal surfaces for solid wire bonding. The Openair-Plasma technology is a cost efficient process and can be integrated inline, allowing the bonding process to take place directly after the cleaning is completed.

"Metal can be cleaned using three processes which have different effects and have different treatment goals," says Nico Coenen, Global Business Development Manager Electronics Market of Plasmamatreat GmbH, explaining the basic possibilities of plasma treatment. The first process, neutralization, involves the removal of both surface charge and statically bound dirt such as dust particles. This is done by the charge carriers of the Openair-Plasma treatment. In the second process, the volatile components such as moisture and VOCs (volatile organic compounds) are eliminated by evaporation through the thermal effect of the Openair-Plasma treatment. The final cleaning process is removing organic contaminants. The reactive nature of Openair-Plasma causes hydrocarbon chains to be broken down and split into smaller, volatile molecules (up to H₂O and CO₂).

The successful treatment can be verified, for example, by using an atomic force microscope, which provides visual evidence of the change in the surface. This is a special scanning probe microscope which is used in surface chemistry for mechanical scanning of surfaces and for measuring atomic forces on the nanometer scale. Furthermore, the contact angle method can be used to prove the modified surface tension e.g. by a drop of water. The water drop on the plasma-treated surface changes its wetting properties in such a way that the contact angle and height are reduced and the surface is becoming more hydrophilic.

This is the result of surface cleaning with Openair-Plasma. Especially oxide surfaces, but also contamination caused by bleed out, interfere with the bonding process and prevent reliable connections. Openair-Plasma removes both surface contamination and the oxide layer and the clean surface of the metal alloy is revealed. This is beneficial, in semiconductor applications as particularly clean surfaces are required here in order to reliably bond the ultra-fine wires. The plasma-treated surface allows bonded materials to form a more stable and larger-area connection.

A similar process is used to remove copper oxides, especially in semiconductor and LED applications. By using X-ray photoelectron spectroscopy, the chemical composition of solids and their surface can be determined without causing damage. After treating copper, it can therefore be determined that the surface proportion of copper increases from 3% to 38%, with a concomitant reduction in the carbon content from 43% to 18%. "These changes clearly show that the copper oxide has been reduced and the copper surface area increased," says Coenen. The contact angle analysis also shows a comparable result. Bond wires therefore also form reliable connections here.

In addition to aluminum and copper substrates, nickel surfaces show similarly good properties after being treated with Openair-Plasma. This is particularly important in battery production. Since nickel oxide acts like a barrier layer, which massively complicates the connection with other materials, the cleaning of the nickel surface from oxides is essential. Plasmamatreat has therefore developed a special jet for this application that matches the general requirements and at the same time meets the temperature requirements of the process step, for example does not exceed the limit of 50° Celsius.

"The degree to which the individual substrates allow stable wire bonding depends on the material in use. However, the upstream plasma surface treatment improves the application window of the wire bonding process in any case. Both wettability and adhesion are optimized," says Coenen.

About Plasmamatreat

Plasmamatreat is the worldwide market leader in Atmospheric plasma applications for cleaning and activation of all kind of surfaces. You can find the Openair-Plasma® applications in automated production lines in almost any type of industry. Plasmamatreat has production centers in Germany (headquarter), USA, Canada and China and has more than 30 subsidiaries and partners around the world.

More information: www.plasmamatreat.com

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Openair-Plasma treatment in LED production.

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