

Atmospheric pressure plasma for process improvement in wire bonding

Atmospheric pressure plasma is used in wire bonding as a selective fine cleaning step to remove contamination and residues from the contact surfaces. In general, strong bonds between wire and substrate can only be achieved on clean contact surfaces (bond pads). Thus, plasma treatment has a considerable effect on the quality and consequently the reliability of the entire component. Together with TPT Wire Bonder from Karlsfeld and the joint partner Axend Pte Ltd., relyon plasma has investigated the effects of cold atmospheric pressure plasma on wire bonding with gold wire.

Regensburg / Karlsfeld. Ideally, wire bonding is applied to clean metal surfaces (bond pads) of semiconductor components or carrier materials. In practice, however, there are often contaminations on the surface, which can result in non-stick on pad (NSOP) or so-called "lifts" (elevations of the bonds). Both cases lead to failures, downtimes and quality defects in production. For this reason, atmospheric pressure plasma is used in this process for selective fine cleaning prior to wire bonding, which avoids NSOPs as well as lifts and increases quality.

Investigation of the ball shear strength before and after plasma treatment

A test circuit board of ENEPIG surface ("Electroless Nickel Electroless Palladium Immersion Gold") was treated on one side with the atmospheric pressure plasma high performance system plasmabrush® PB3 at a distance of 20 mm for 0.5 seconds with a compressed air plasma. Subsequently, 60 bond connections (30 balls and wedges) were applied to the untreated and plasma-treated test circuit board with the TPT HB16 Wedge & Ball Bonder. The plasma pre-treatment is intended to create a stronger connection between the bond pads and the wire.

In visual comparison, the ball bonds on the untreated and plasma treated ENEPIG surfaces seem to be firm and there are no problems with the Bond-Stick during wire bonding process. In order to measure the difference between the plasma pre-treated and the untreated ball bonds, a shear test is performed with the XYZTEC Condor Sigma Bond Tester, which shows a significant difference in quality between the two test series. An average shear strength of 60.89 gf is measured for the 30 samples without plasma pre-treatment before the ball bond is completely detached from the ENEPIG surface. Only a barely visible imprint of the sheared wire contact remains on the bond pad, a typical feature for the failure of the intermetallic bond between gold wire and ENEPIG surface.

In contrast, the bonds on the plasma pre-treated surfaces show a completely different behaviour in the shear tests with an average shear strength of 68.34 gf: The fracture pattern shows a sheared ball bond, leaving wire material on the surface. The shear strength of the bonds on the plasma pre-treated surface is therefore only limited by the shear strength of the wire itself. The results show that the intermetallic bond between the ENEPIG surface and the gold wire can be improved by plasma pretreatment to such an extent that it is significantly stronger than the strength of the gold wire material.


Wire pull test for wedge bonds before and after plasma treatment

For wedge bonds a wire pull test is performed with the XYZTEC Condor Sigma Bond Tester. Inconsistent test results occur with wedges applied without prior plasma treatment, proving that the bond is not ideal although it doesn't seem critical. All in all, most wedges applied without plasma pre-treatment show so-called lifts, which indicate a weak intermetallic wedge bond. In case of wedges applied to the plasma pre-treated surface, no failure in the wedge

area occurs. All fracture patterns that appear are either within the wire itself or directly in front of the bond point (span or neck break), indicating that the bonds of both the ball and wedge are strong and therefore the wire only breaks in the area between the two bonds.

The results clearly show that surface treatment with atmospheric pressure plasma leads to significant improvements in both ball and wedge bonding, as clearly demonstrated in both ball shear and wire pull tests.

Technical data plasmabrush® PB3



Input voltage:	220-240 V AC, 50-60 Hz
Max. Power:	1 kW
Design of power source:	19-inch rack
Communication:	CANopen, Digital I/O
Gas flow (CDA, nitrogen, forming gas):	25 to 80 L/min
Cable length:	10 m
Weight of plasma generator:	680 g
Diameter of plasma generator:	32 mm
Typical treatment width:	15 – 25 mm

About TPT Wire Bonder

TPT Wire Bonder GmbH & Co. KG is an owner-managed company that develops and manufactures manual and semi-automatic wire bonder with over 30 years of experience in wire bonding and die bonding technology. The company was founded by Franz Hickmann in 1996 and has been family owned ever since. All machines are manufactured in Karlsfeld close to Munich and are installed in over 60 countries. A worldwide dealer network ensures good advice and fast service on site. Together with customers, start-ups, universities and corporations, new ideas and applications for microelectronics shall be enabled.

Contact:

TPT Wire Bonder GmbH & Co. KG
Einsteinstraße 10
85757 Karlsfeld, Germany
Tobias Hickmann
Tel: +49 8131 5860 4
<https://www.tpt.de/en/>

About relyon plasma GmbH

relyon plasma GmbH, a subsidiary of TDK Electronics based in Regensburg, Germany, develops innovative plasma systems. True to the motto "rely on plasma", the company sees itself as a professional supplier of plasma systems and service provider for individual customer requirements. Thanks to many years of professional experience in the industry, relyon plasma now offers a wide range of specialized plasma components for manual applications and in-line processes. Atmospheric pressure plasmas generated by electrical discharges in air or other gases have a remarkable combination of properties that enable unique surface treatment. Such plasmas produce large quantities of very reactive but short-lived chemical species. These can disinfect, clean, modify and functionalize a wide range of surfaces and prepare them for bonding, painting and printing.

Contact:

relyon plasma GmbH
Osterhofener Str. 6
93055 Regensburg, Germany
Andrea Werkmann
+49 941 60098270
a.werkmann@relyon-plasma.com
www.relyon-plasma.com

About Axend Pte Ltd

Axend Pte Ltd is a Distributor / Representative for various suppliers in the Electronics Process Assembly Industry. We work throughout the SE Asia region including Singapore, Malaysia, Thailand, Philippines, Vietnam and Indonesia. Axend is designed around a philosophy of not only providing a product, but providing a complete process solution wherever possible. Axend is the distributor for both TPT and relyon plasma, along with wedge tools and bonding capillaries in order to provide a complete wire bonding process.

Contact:

Axend Pte Ltd
100D Pasir Panjang Rd, #02-02 Meissa
Singapore 118520
+65 6748 7011
markbarden@axend.biz
www.axend.biz

Picture credits:



Image 1: Logo TPT Wire Bonder



Image 2: TPT HB16 Wedge & Ball Bonder

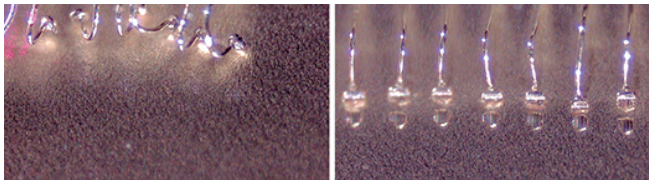


Image 3: Ball shear strength on untreated (left) and plasma pre-treated (right) ENEPIG surface

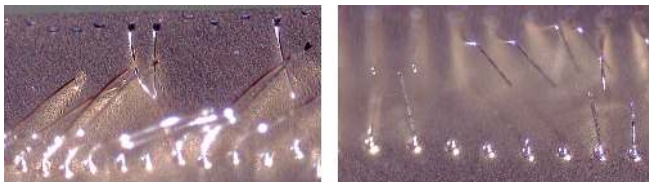


Image 4: Wire pull tests of bonds on untreated (left) and plasma pre-treated (right) ENEPIG surface



Image 5: plasmabrush[®] PB3 high performance plasma system