From credit cards to mobile phones, from car electronics to notepads, semiconductor devices are a part of our daily life. Design and manufacturing processes have evolved many years now from DIP to CSP, but there are still many processes that require the cleaning of metal surfaces prior to wire bonding or before molding of the semiconductor housing. Oxide layers and contaminated surfaces cause low wire bond strength and lead to electrical contact failures, especially under changing mechanical stress applied on the bonds, for example in the course of temperature changes.

Contaminated surfaces cause also delamination after the molding of the semiconductor package and lead to moisture soak, resulting in the worst case in corrosion effects and electrical parameter drift. As a standard, contaminations are removed by using organic solvents or special cleaning liquids, as in the case of the removal of solder flux remnants.

Low pressure plasma processes can remove oxide layers and weaker organic contaminations. High equipment costs and long process times, however, are the drawbacks of low pressure plasma processes.

Openair® reducing plasma provides fast and efficient removal of oxide layers, solder flux and glue remnants.

Openair® reducing plasma provides the removal of oxide layers, of strong contaminations, such as solder flux, and of weak organic contaminants in one single process. A special combination of gas mixture and a novel nozzle type allows to generate a strongly reducing atmosphere around the samples while being treated. The number of active radicals and ions per volume unit is by magnitudes larger than in a low pressure hydrogen plasma and allows for very short treatment times.

By the unique design of the nozzle and the gas mixture, the treatment of such metal surfaces is possible that can normally only be treated in low pressure plasma or under protective atmosphere, for example in the case of copper. Copper is very sensible to oxidization, especially under elevated temperatures. By Openair® reducing plasma treatment, copper leadframes carrying solder flux contaminations, can be cleaned very fast and without any reoxidation of the copper after cleaning. Typical times for cleaning a leadframe with a length of 110 mm from solder flux are about 20 seconds (see pictures below).
The picture below shows a solder flux contaminated leadframe before and after treatment with Openair® reducing plasma. No discoloration of the copper frame after the cleaning could be detected. By the geometry of the nozzle, the thermal stress on the treated parts is lower than for comparable forming gas atmospheric plasmas. This allows the treatment of PCBs and MCBs with a resist on top without causing thermal damage. The plasma is potential-free, a chip damage by ESD shock can be excluded.

Besides Semiconductor applications, the process can be applied to LED packages, too. For example, Ceramics and MCB carriers can be treated after the die bonding prior to wire bonding. Because of the process speed, Openair® reducing plasma is a valuable alternative for low pressure plasma processes and helps to save equipment cost and to increase the yield per time unit.

The nozzle and the aligned equipment should be adapted to the special leadframe or submount type to provide an optimized gas flow and to maximize the cleaning effect. The results described above are based on a first approach, using a nozzle that has been modified in a simple way.

By that, a further process improvement with respect to reducing the treatment time can be expected. Ongoing measurements of the thermal stress on treated samples will lead to more precise statements, which kind of packages can be cleaned by this kind of plasma.

All evaluations have been done using a standard Openair® Plasma equipment. For production purposes, the equipment will look as shown below, making use of a magazine handler. Alternatively, a reel to reel process can be implemented easily with this plasma technique.