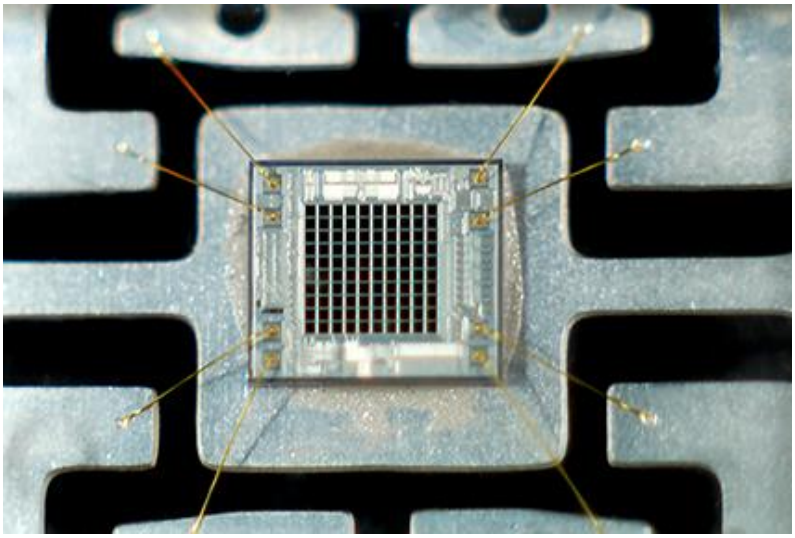
Optimizing cycle times in the semiconductor industry with Openair-Plasma

For selective plasma surface treatment during the production of semiconductor components, the technology leader Plasmatreat GmbH from Steinhagen supplies a fully automated inline system set up according to customer requirements.

The technology involved in plasma surface treatment can be used in many ways in the field of semiconductor manufacturing. This special process can be used for surface treatment in wire bonding and die bonding, thermal compress bonding, and pre-molding. A distinction is made between two different plasma processes: With the low-pressure plasma process, several components can be treated simultaneously with plasma in a vacuum chamber; however, the associated equipment costs and long process times can prove disadvantageous, and it is not possible to treat individual components on a selective basis.



The processing of plastic- or metal-core-based PCBs, but also ceramic and LS switch carriers can be gently and reliably pretreated with plasma technology after die bonding and before wire bonding.

The Openair-Plasma process developed by Plasmatreat, on the other hand, allows components to be treated both selectively and specifically. Based on one or more jets, this process works with compressed air, does not require any cost-intensive gas, and can also be guided on a highly flexible basis by a robot. What's more, it is also possible to use Openair-Plasma in the production process both inline and as an isolated solution. The process is suitable for surface treatments such as microfine cleaning, surface activation, and plasma coating of virtually all materials such as plastics, metals, glass, ceramics, and composites. Furthermore, the Openair-Plasma technology is also suitable for cleaning all metallic surfaces.

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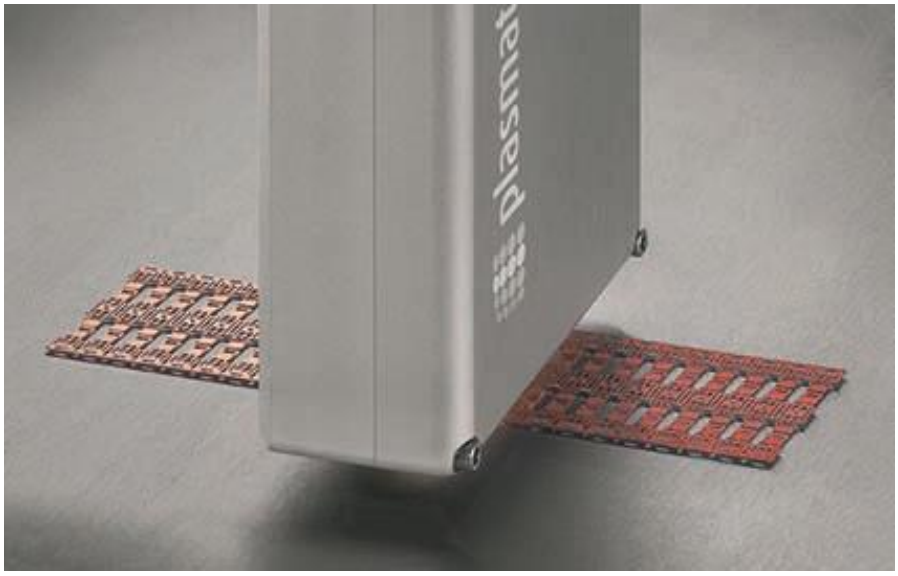
Openair-Plasma typically uses clean dry air as a process gas whereas vacuum plasma uses much more expensive noble gases like argon, helium or oxygen. However for the treatment of copper leadframes, Openair-Plasma also uses a combination of nitrogen or forming gas. Since this element is extremely sensitive to oxidation, especially at higher temperatures, only low-pressure plasma systems or processes under a protective atmosphere are normally used for this. Reducing treatment with Openair-Plasma, on the other hand, allows copper lead frames to be cleaned very quickly without any noticeable discoloration of the copper frame. The low thermal stress on the components makes it possible to perform tasks such as processing PCBs with a plastic or metal core without thermal damage, and it is even possible to treat ceramic and LS switch carriers after die bonding and before wire bonding. As for chip damage caused by electrostatic charges, this is excluded thanks to the electrically neutral plasma jets.



Lead frames can also be cleaned of unwanted oxide layers with Openair-Plasma and suitable jets before further processing.

Designed to meet specific requirements

The semiconductor industry has already been using the plasma products manufactured by Plasmatreat for some time. Nevertheless, a request from a long-standing customer provided the impulse to develop a special Plasma Treatment Unit (PTU) for the semiconductor industry. "As an established system supplier for our PTUs, we were happy to take on this very specific request," says Nico Coenen, Market Segment Manager Electronics at Plasmatreat. The PTUs are individual manufacturing cells that are designed to suit the customer's process engineering workflows and can be seamlessly integrated into production lines. They also offer various handling and automation options that enable coordinated process automation for efficient surface treatment and precise handling of assemblies and components. "Since we already manufacture fully automated systems for other industries, we already had the internal design and automation expertise required to develop and implement the system requested by the customer. That said, we still expanded our testing capacities at the Steinhagen site and set up a Class 6 clean room to

handle this special customer project and others," Coenen explains further. With extensive competence and expertise, Plasmatreat was able to develop this specific system for the semiconductor industry. The various tasks at hand included integrating vacuum clamping devices to fix the component trays and using SECS/GEM-based protocol interfaces.

"In order to develop an inline-capable system for the semiconductor industry and be able to guarantee the highest possible cycle times, we had to take several process steps into account and implement these with precision as early as the conception phase," stresses Coenen. "For example, we have planned for the parallel handling (in the form of a dual-lane concept) of two depositing devices on two conveyor belts within a single system. We read barcodes to be able to trace each chip, and we can also treat individual components selectively, which allows us to perform tasks such as only treating the top of a component with plasma. This specific treatment is not possible with vacuum plasma, for example."

With the dual-lane concept, the first conveyor belt transports two filled trays one after the other to defined positions where the plasma treatment takes place. As soon as the treatment of the components on the first conveyor belt is completed, the two plasma jets move to the second conveyor belt and process the components located there.

Maximum throughput

The dual-lane concept, as it's known, which adapts to the customer's individual cycle times, is essentially designed to handle different applications. This allows the system to achieve a maximum throughput per square meter. Designed for both JEDEC trays and lead frames, the system is capable of processing trays with 8 or 128 components. What's more, the first step of the latest PTU involves reading out the barcode of the components transported in a JEDEC tray on the fly by means of a camera. This allows each individual component to be traced. In the next step, the components are fixed in the JEDEC tray compartments by creating a vacuum. The subsequent surface treatment is carried out using the RD1004 rotary jets, which are equipped with an integrated suction system. Once the plasma surface treatment is complete, the components pass through an

external selective flux module where they are prepared for the subsequent thermal compress bonding process.

The dual-lane concept allows different processing concepts that correspond to the cycle time. For this purpose, the first conveyor belt transports two filled trays, one after the other, to defined positions where the surface treatment takes place. At the same time, the second conveyor belt transports two more loaded trays to the respective processing positions. As soon as the surface treatment of the components on the first conveyor belt is completed, the two plasma jets move to the second conveyor belt and process the components located there. As the finished trays leave the system, the next ones move in. Communication within the production line takes place via the standard equipment interface protocol interface in the semiconductor industry, SECS/GEM.

"Time and again, the electronics industry is confronted with a shortage of components, and factors such as the rise in electromobility are not exactly helping to ease the situation. We want to counteract this with our expertise," Coenen emphasizes. This is why the experts also want to design and implement individual plasma solutions for the fields of automation and mechanical engineering. The aim here is to create cycle-time-optimized alternatives in the production of chips and microprocessors.

About Plasmatreat

Plasmatreat is an international leader in the development and manufacture of atmospheric plasma systems for the pretreatment of substrate surfaces.
Whether plastic, metal, glass or paper – the industrial use of plasma technology modifies the properties of the surface in favor of the process requirements.

Openair-Plasma® technology is used in automated and continuous manufacturing processes in almost every industrial sector. Examples include the automotive, electronics, transportation, packaging, consumer goods and textile industry, but the technology, cost and environmental advantages of the plasma technology are used in medical technology and in the renewable energy sector as well.

The Plasmatreat Group has technology centers in Germany, USA, Canada, China, and Japan. With its worldwide sales and service network, the company is represented in more than 30 countries by subsidiaries and sales partners.

For more information, please visit: www.plasmatreat.com