Stripping paint and cleaning surfaces using atmospheric plasma

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In this contribution we show efficient paint removal using an atmospheric plasma torch..

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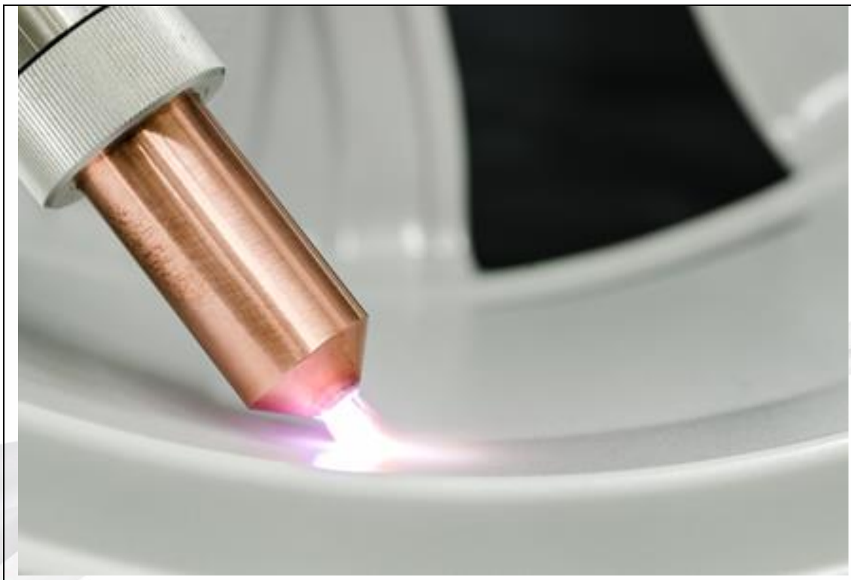
Introduction

To date, atmospheric plasma treatment has been considered mainly a method of fine cleaning which only affects the immediate surface. It used to be impossible to neatly remove gross contamination or thicker layers (Weyer, Hinderer , Huhsmann, Stehr, & Wenders de Calisse, 2003). Typically, thicker layers (>1/100mm) were first removed mechanically e. g. by grinding, sanding, polishing or brushing and subsequently cleaned further (Hofmann & Spindler, 2014). These methods produce large quantities of dust and can damage the product surface. Another well-established method is combustion by flame or hot air. This may not produce dust, but - depending on the composition of the layer - a high emission rate of hazardous gases. Similarly, wet-chemical methods using aggressive etchant are not without risks during application. Any residue of these pickle may lead to corrosion of components later and thus have to be removed completely after the process. Modern methods such as laser cleaning or dry-ice blasting (using CO_2) cannot be applied in some cases and, moreover, may end up being very cost-intensive. Dry-ice blasting requires a continuous supply of CO_2 blasting agent, whereas atmospheric plasma cleaning only calls for a grid connection and compressed air.

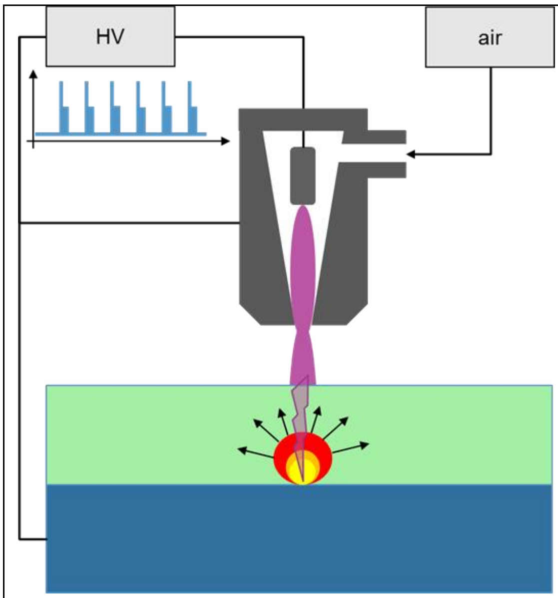
Basic principle

In order to effectively remove a layer from a surface, the best spot to target is generally the interface between the two materials. Successfully focusing the power of the stripping mechanism on exactly this inner surface maximizes the efficiency of the process. Doing so does not require removing the layer in its entire thickness step by step, but instead the interface is stressed to the point where the whole layer comes off in one.



Picture 1 shows an intense plasma flame in direct interaction with a powder-coated aluminum wheel rim.

An atmospheric pressure plasma torch whose voltage source can generate a high voltage swing can be operated in a way causes an electrical breach in an insulating or barely conductive layer which covers a conductive material. A high, pulse-like amount of energy is released at the junction between the insulating layer and the conductive carrier. Short pulses will release a thermomechanical shock wave which causes the layer to be blasted off at a well-defined spot. If the plasma flame is operated at a high pulse frequency and screened across a surface, it becomes easy to strip and clean coherent areas. A large portion of the heat output is dissipated by the stream of air coming out of the nozzle. This stream of air simultaneously blows loose particles off the stripped surface.

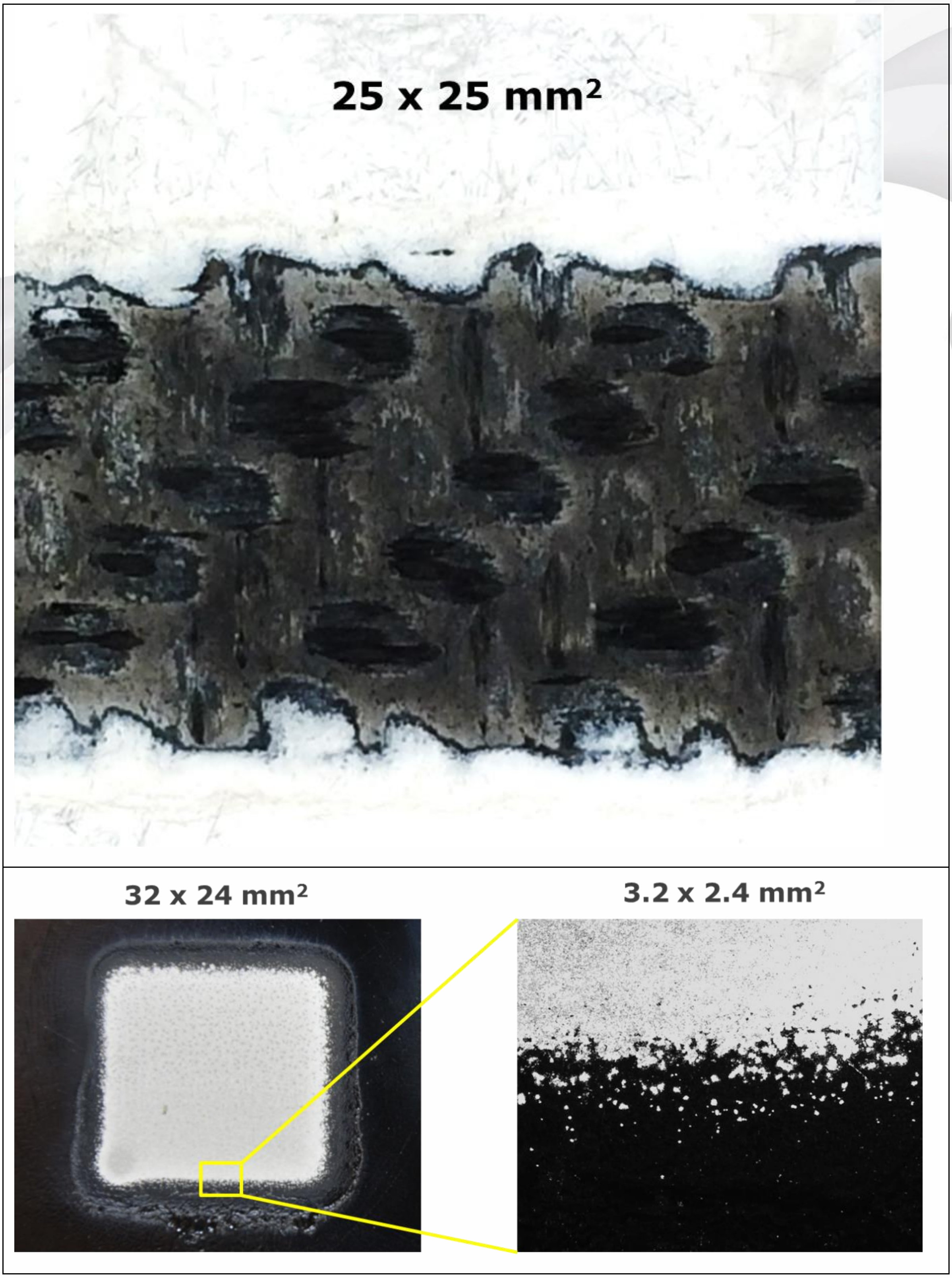


Picture 2 Localized pulsed energy input at the time of the electrical breakdown. The highest power loss occurs at the cathodic base point on the grounded conductive substrate. Operated with compressed air and pulsed high voltage supply.

Result and case study

This innovative method enabled us to effectively remove varnish layers more than 1mm thick using a plasma jet. Combustion is minimal and there is hardly any thermal stress or mechanical damage. The result is a clean surface with fine roughening which has hereby been optimized for further processing steps. Gluing, contacting or coating are possible options.

For our studies, the Plasmabrush PB3 plasma system was integrated into an xyz axis unit (PlasmaCell 300) and operated in removal mode. This system allows for screening velocities of up to 800mm/s.



Picture 3 The image above illustrates a covering layer of synthetic resin varnish being removed from a structural component made of carbon fiber reinforced plastic (CFRP). It is clearly visible that the fibers have been slightly bared. The sequence of images below show an area on an aluminum substrate which has been scanned clean.

The plasma-operated removal process can be conducted both automatically and manually. This way, even hard-to-reach spots or angular areas can well be reached.

The process is suitable for any conductive substrates such as sheet metal, aluminum, and steel, copper or conductive carbon fiber structures. The varnish layer does not have to be conductive.

Picture 4 The cleaning processes were conducted both with a handheld device and with an automated processing cell.

Conclusion

Plasma blasting flexibly lends itself to a wide range of applications and can be used for the following layer systems, among others: release agents, finishing and smoothing, product residue, glue and paste sediments, polishing agent residue, bitumen, waxes, paint layers, and flux residues. Possible areas of application are in production, maintenance and service in almost all sectors of industry.

Literature

Hofmann, H., & Spindler, J. (2014). *Verfahren in der Beschichtungs- und Oberflächentechnik.* Carl Hanser Verlag GmbH & Co. KG.

Weyer, C., Hinderer , K., Huhsmann, E., Stehr, U., & Wenders de Calisse, E. (2003). *Oberflächenreinigung - Material und Methoden. Surface Cleaning - Material and Methods.* Düsseldorf: Konrad Theiss.