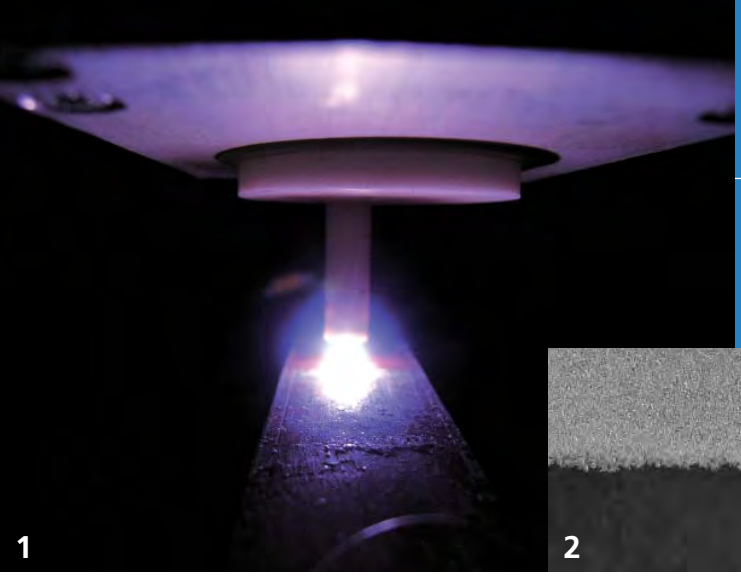

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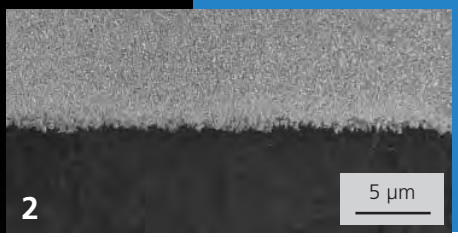


2

CLEANING OF METAL SURFACES WITH ELECTRICAL DISCHARGES AT ATMOSPHERIC PRESSURE OR IN VACUUM

THE TASK

The cleaning or conditioning of metal surfaces is a frequent task in many technical fields. This is in particular important in joining and coating technologies but also is often needed for forming and other metal processing operations, which require pre-cleaning. There are numerous cleaning processes available depending on the type of contamination.

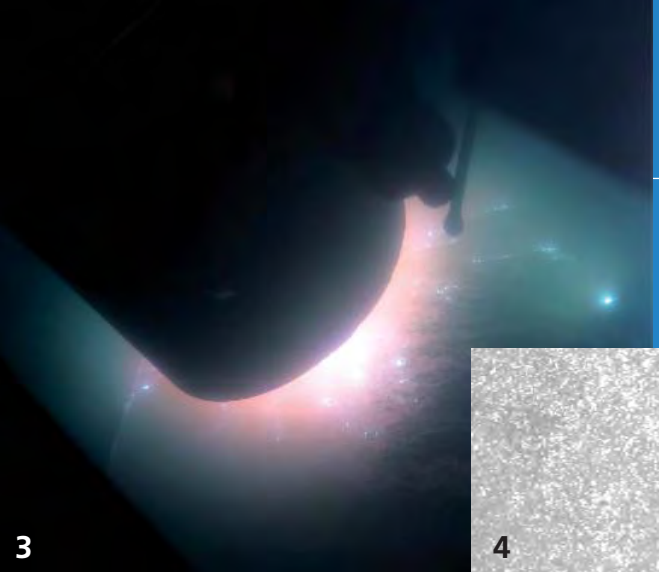
What cleaning process can be applied depends strongly on the detailed cleaning task and the existing setting. Mechanical cleaning processes are useful when there are a few parts that have to be cleaned from rough dirt. Continuously running chemical processes are often applied for large area surface cleaning. However, due to increasing environmental and economic demands the use of classical cleaning processes gets more restrictive. Mechanical cleaning processes suffer wear (brushes) or require additional effort to handle support materials (i.e. media for sandblasting). Chemical processes require copious preparation and safety technology to conform to environmental regulations. Thus, there is the need for cleaning processes that can be applied to various cleaning tasks but also work without the need for supporting materials and do not generate waste products.

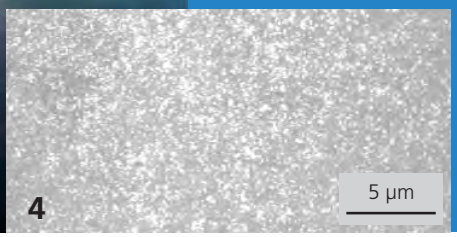
OUR SOLUTION

Electrical arc discharges are equally suitable for localized and large area surface removal operations. The can be used at atmospheric pressure as well as in vacuum.

Localized cleaning at atmospheric pressure:
Pulsed high voltage discharges can selectively clean surface areas at atmospheric pressure conditions. The setup consists of the workpiece to be cleaned and an electrode, which is placed at a distance of several millimeters from the workpiece surface. A generator creates voltage pulses that cause a brief electrical discharge between electrode and workpiece. The discharge removes a limited amount of material from the workpiece surface at a selective processing zone. The electrode is then moved across the workpiece and the discharges are repeated. Discharge by discharge it is possible to clean larger areas. The discharge current, frequency and the speed of the electrode motion can be adjusted. It is also possible to add process gases to the processing zone. These gases support the cleaning process by forcing reaction products out of the processing zone or prevent the formation of new surface deposits.

Large area cleaning in vacuum:
The dc arc discharge is known from coating technologies. It is also an effective tool to remove material from surfaces over large areas. In vacuum, metallic surfaces can be cleaned at high processing speeds. The setup consists of the metal to be cleaned and a counter electrode in the processing chamber. A generator is also needed that provides continuous power to





operate the discharge. The discharge generates microscopically small arc spots on the metal surface, which move at high speed across the surface. Within the arc spots the material abruptly evaporates, which removes only a few micrometer thin layer. The heat input into the workpiece is moderate. Due to the fast motion of the arc spots the material removal occurs in the form of lines, which can be overlapped to clean larger areas. The arc spot motion is controlled by the geometric design of the electrode and by externally applied magnetic fields. The parallel operation of several electrodes increases the processing area.

RESULTS

Both processes were used to clean metal surfaces. They were in particular developed to remove solid contaminations such as scale. The processes also proved to successfully remove fats and oils. The spatially selective process at atmospheric pressure is well suited for situations where a limited surface area needs to be prepared for further processing. That is, for example, the preparation of parts to be joined (welding, adhesive bonding). Fig. 2 shows a metal surface, which was partially cleaned with pulsed discharges. The cleaning is completely based on electrical power. No additional support materials are needed. The processing gas is typically air. In some case nitrogen or argon are used.

Fig. 4 shows a metal surface that was cleaned with a highly productive process in vacuum. The cleaning was performed in fine vacuum. The processing speed depends on the characteristics of the applied discharge and the setup. It can be varied over a wide range. Areal removal rates of several square meters per second are technically controllable. The cleaning process causes a slight roughening of the surface, which is in particular useful for the preparation of joining processes such as adhesive bonding.

1 Cleaning of metal surface with electrical discharge at atmospheric pressure
2 Partially cleaned metal surface
3 Vacuum arc discharge to remove contaminations from metal surfaces
4 Large area cleaned metal surface

CONTACT

Dr. Otmar Zimmer
phone +49 351 83391-3257
otmar.zimmer@iws.fraunhofer.de