Plasma Electrolytic Oxidation with Alternating Current and Asymmetric Electrodes

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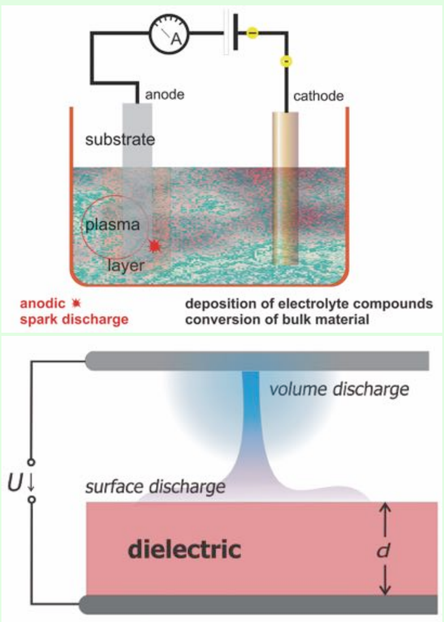
Motivation

Plasma electrolytic oxidation (PEO) is an electrochemical process to create ceramic-like oxide coatings on light alloys like aluminum, magnesium and titanium.
The major difference in PEO is that the anode-potential reaches the dielectric breakdown voltage, which causes discharges on the surface. This results in interesting tribological properties as well as high biocompatibility and durability.

Our goal

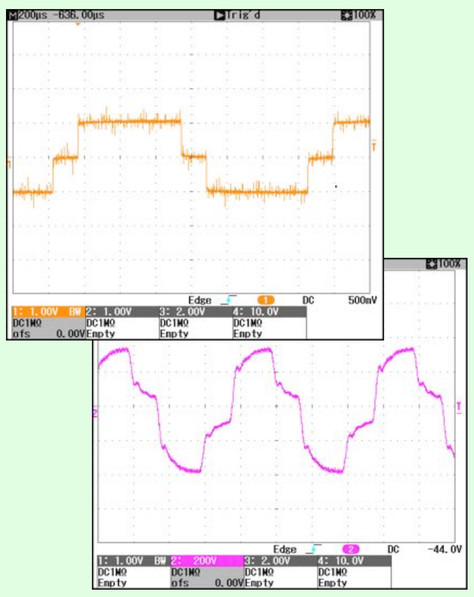
Coating two objects at the same time doubles the efficiency of the process. In practice, however, this is difficult to achieve because of differing electrode sizes and shapes. The coating process is also inherently unstable towards one of the electrodes: the coating on one of the objects grows faster, which leads to a runaway effect of the process.

Plasma Electrolytic Oxidation - PEO



- Plasma electrolytic oxidation (PEO) is an electrochemical process to create ceramic-like oxide coatings on light metal alloys
- Similar to conventional anodizing, in PEO the coating process occurs on the anode
- The major difference in PEO is that the anode-potential reaches the dielectric breakdown voltage, which causes discharges on the surface
- This results in interesting tribological properties, high biocompatibility and durability
- PEO increasingly important for material and surface technologies that are used in optical, space and medical applications
- Existing applications use an insoluble cathode
- *Use of AC and same electrode*

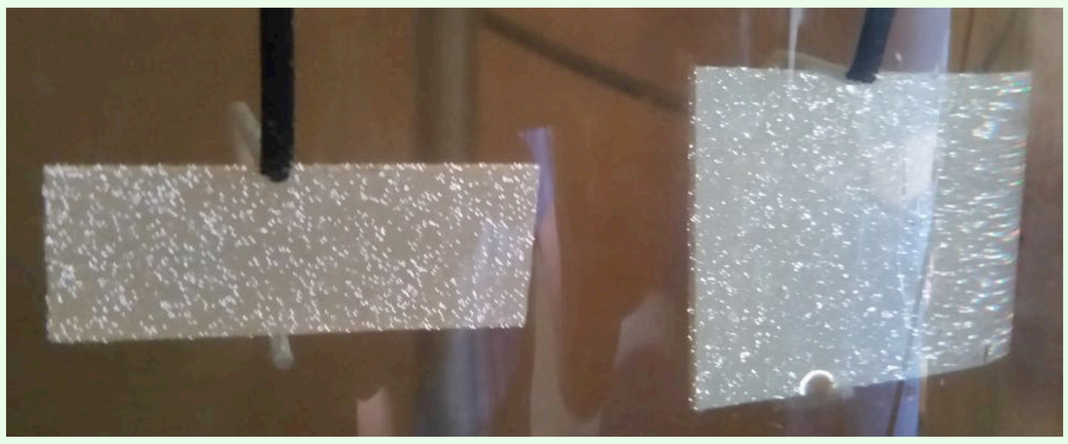
Power Supply and Electronic Control

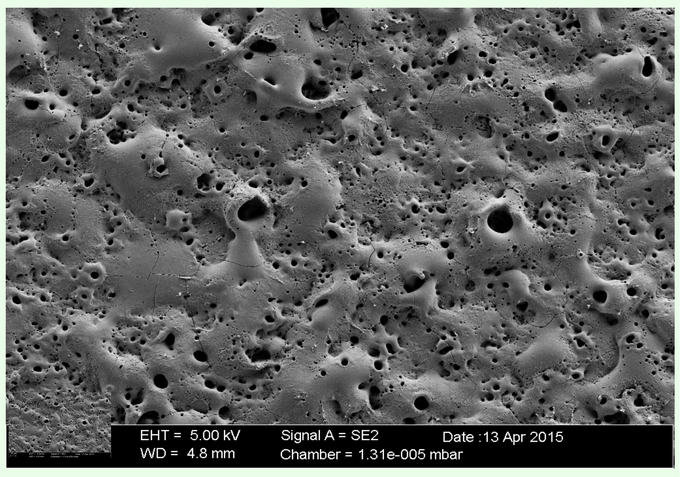


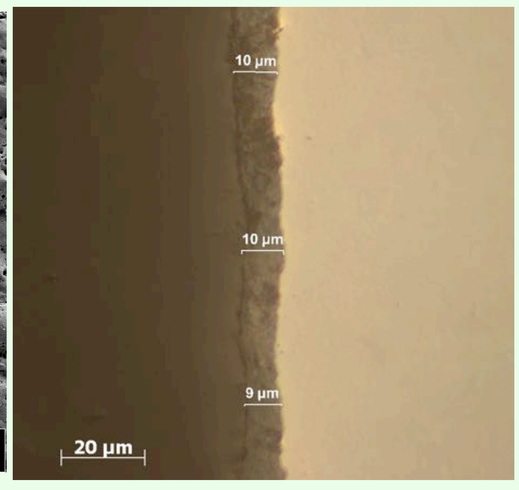
- A current controlled power supply was designed for this research project which facilitates adapting current pulse shapes by symmetry, duty-cycle, offset and frequency.
- A higher-level control unit compensates asymmetries of the electrodes by adjusting optionally either the symmetry or the offset of the current pulses.
- It was shown that by carefully controlling these parameters it is possible to coat asymmetric objects and achieve a stable process.
- This process was successfully embedded into a complete PEO process sequence, which allows to create PEO coatings reproducible and fully automated.

Results

- Development of an alternative power source for the process of anodic oxidation, especially the plasma chemical oxidation in the power range up to 30 KW with loading special feature to carry out a coating independently of the real surface conditions at the anode and cathode in the pulsed AC operation
- This opens up the possibility of bringing to coated components not only as an anode in the electrochemical bath but also to use as a second electrode. So far as the cathode insoluble materials (eg. Cr-Ni steels) are used or when using pulsed AC has been meticulously in the same surface conditions are respected at both electrodes.
- With the newly developed power supply, it will be possible to conduct a constantly optimum coating on both electrodes, regardless of the surface conditions
- There is thus an increase in productivity of the coating of 100%.
- With the application of pulsed AC voltages, the properties of the layer systems can be varied within wide limits.







Summary

- It has been shown that the application of pulsed alternating current (AC) improves the quality of the coating
- Using AC also allows for coating two objects simultaneously, with each object acting as one of the electrodes
- This is possible since each electrode functions as the anode during its corresponding negative pulse half-cycle
- Up to an electrode ratio of 1: 4 to achieve the same surface properties on both electrodes
- We have developed a power supply and an electronic control system that adjusts current and waveform to stabilize the AC-PEO process
- The system facilitates uniform coatings on asymmetric electrode configurations, which opens the technology to new applications in research and development as well as for industrial use

- Please visit and contact us in the industrial exhibition

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