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In-situ statistics of microdischarges by image processing as a means of process control during plasma electrolytic oxidation (PEO)

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Plasma electrolytic oxidation is a plasma enhanced process for the passivation of lightweight metals (Al, Mg and Ti alloys). Microdischarges formed in the electrolyte-ceramic and gas-ceramic interface change the compostion of the produced ceramic. A large amount of physical and chemical processes are involved on many time and length scales.
A unique characteristic of this process is the stochastic production and self-extinguishing of microdischarges. The collective behaviour of microdischarges changes over the course of treatment time. A thicker coating results in larger microdischarges and reduced number density. Arcing may occur after prolonged treatment time and diminishes coating quality. During unipolar pulsing, the duty cycle can be used to initiate a so-called ‘soft mode’, which is characterized by a large number density of discharges with low individual energy.
The authors present a measurement method for in-situ microdischarge characteristics like number density and discharge intensity. A CCD-Camera records the microdischarge emission during treatment time. Image processing analyzes microdischarge statistics between two consecutive exposures. Microdischarge information is then used as feedback signal for process control. The duty cycle is controlled to maintain stable microdischarge properties over treatment time. To correlate the change of process parameters to coating properties, analysis of defect statistics (cavities and cracks) is performed by SEM measurements and image processing.

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