Transient Simulation of the Removal Process in Plasma Electrolytic Polishing of Stainless Steel

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Abstract

Plasma electrolytic polishing (PeP) is an electrochemical method for surface treatment. In detail PeP is a special case of anodic dissolution [1] that unlike electrochemical polishing requires higher voltage and uses environment friendly aqueous solutions of salts. When the process starts, the anode is covered with a plasma-gas layer. During processing, the surface of the workpiece becomes smoother and get higher gloss level. Due to small achievable roughness (Ra < 0.02 µm) and small removal rates [2], this process is applied for finishing of precision parts.
In recent years, a lot of studies on PeP have been made. Nevertheless, at presence, only a few research work has been focused on the understanding of the process basics.
To investigate the basics of PeP a 2D simulation model was developed. Geometry and boundary conditions are based on principle scheme shown in Figure 1. The model set up and calculation were made in COMSOL Multiphysics ®. Electric Currents and Deformed Geometry interfaces were chosen for this model.The initial anode surface profile was generated in COMSOL Multiphysics® using Spatial Frequencies method [3]. This was made to simulate the polishing effect of PeP. The anode is placed inside the basin with electrolyte with a conductivity of 120 mS/cm. The side and bottom boundaries of the basin are grounded. Voltage of 200 V is applied to the anode boundaries.
In this model, a special interest is focused on the plasma-gas layer and the electric potential. The thickness of the plasma-gas layer and its conductivity are based on experimental data [4, 5]. Material removal is realised as a function of the current density at the workpiece surface.
The paper shows that the main voltage drop in PeP occurs in the plasma-gas layer and that primarily the profile of the surface determines the distribution of current density. Both effects have a main significance in the polishing process. Furthermore, the polishing effect on the surface profile will be analysed.

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Figures used in the abstract

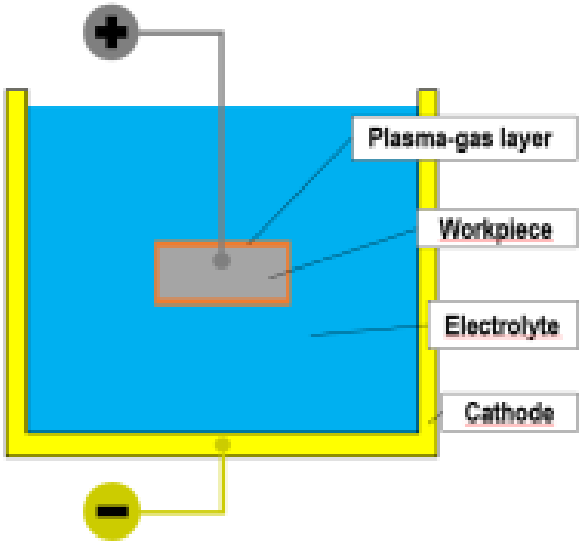

Figure 1: Principle scheme.