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Influence of the Electrolyte Streaming on the Thermal and Qualitative Behaviour of Laser Chemical Machining of Metals.

ABSTRACT - Masterthesis

Laser chemical etching is a non-conventional subtractive processing method. It is based on laser activation of a material dissolution of metals in electrolyte ambient via local induced temperature gradients. The heat impact of the laser beam can induce or enhance reactions of at the metal-liquid interface via changes in the electrochemical Nernst-potential. The related heat transfer coefficients of the electrolyte ambient are strongly influenced by the streaming conditions of the liquid.

At BIAS two different concepts of electrolyte pumping are followed. The first comprises a closed chamber, in which the electrolyte is pumped horizontally whereas the second is based on a coaxial arrangement of a vertical electrolyte jet combined with a focused laser beam via a nozzle.

An experimental study was carried out to investigate laser chemical etched cavities of stellite 21 and titanium (3.7024). The cavities were created using vertical and horizontal streamline of phosphoric acid under the variation of laser power and feed velocity. The resulting cavities were characterized regarding width and depth using laser confocal scanning microscopy. The influence of laser power, feed velocity and streamline condition of electrolyte on resulting removal cavities has been determined. Moreover, the transition from disturbance free removal to disturbed removal depending upon above mentioned factor has been discussed. In order to interpret the cooling effect of electrolyte solution, Green's function-based modelling has been extended. To understand the occurrence of disturbance and temperature dependent electrolyte boiling, this investigation has been supported with high speed shadowgraphs to visualize the interaction zone during the LCM-process.