Effect of Electrochemical Dissolving in Laser Drilling Assisted with Jet Electrochemical Machining

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Laser Drilling assisted with jet electrochemical machining (LD-JECM) has been proved be a useful way for machining high quality holes without recast layer and spatter. In this paper, details of LD-JECM about theoretical analysis on electrochemical dissolving and experimental study on machined quality were performed using 321 stainless steel as workpiece material. Based on the analysis of different material removal mechanisms in pulse width and inter pulse of laser, the temperature field of laser drilling and electric field of jet electrochemical machining were simulated separately. The simulation results show that there is an electric field gradient in the processing area and electrochemical dissolving at the edge of entrance is the strongest, which is proved by the blind-hole experimental results that have removed the spatter around the entrance and expanded the diameter of hole. Additionally, the through-hole experimental results show that recast layer adhered to the sidewall have been completely removed and the exit of the hole is very clean without any spatters. On the surface of sidewall, there are not grain boundary corrosions and only a few of micro pitting. Furthermore, the applied electrochemical voltage and inter electrode gap both affect the taper. It has been observed that within an optimized process parameters window i.e. electrochemical voltage 120-200V and inter electrode gap 1.5-2.5mm, high quality surfaces and high forming accuracy are obtained with less defects. Overall, this work has shown that LD-JECM has a high potential for micro-hole precision machining on difficult-to-machine materials.

Keywords: Laser drilling; Jet electrochemical machining; Electrochemical dissolving; Recast layer; Taper

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