

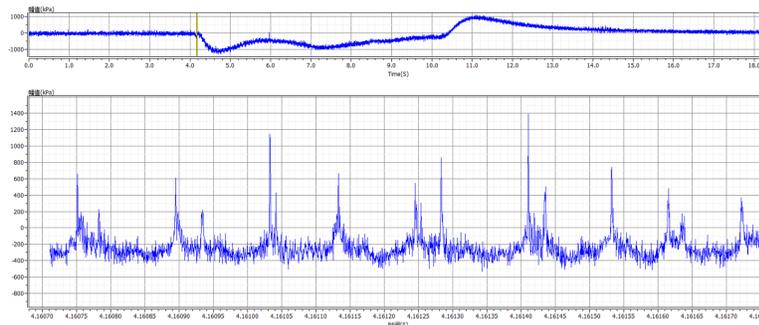
Research progress of pressure detection and applications in liquid-assisted laser machining

Zhouquan Cao¹, Xiaozhu Xie^{1*}, Weifang Chen^{2,3}, Xin Wei¹, Wei Hu¹ and Qinglei Ren¹

¹School of Mechanical and Electrical Engineering, Guangdong University of Technology, Guangdong 510006, China;

²School of Mechanical and Electrical Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China;

³Jiangsu Key Laboratory of Precision and Micro-Manufacturing Technology, Nanjing 210016, China



The pressure signal by multi-pulse laser-induced backside wet etching sapphire substrates.

Abstract: Liquid-assisted laser machining (LALM) is a composite manufacturing technology. During liquid-assisted laser machining, the liquid has the functions of cooling and cleaning on the processing area. It makes the heat affected area of the work piece become smaller. The thermal stress is reduced, and the processing incision is smooth and cleaning. So the liquid-assisted laser machining has unique advantages in the processing of heat sensitive materials, high harden-brittle materials and materials of high precision requirements. Due to the addition of liquid in the laser processing, the laser interacts with the machined and the added working liquid. Some researchers have found that the pressure in the process of liquid-assisted laser machining is produced through the study of the experiments and simulation. The existence of pressure results in the complexity of the laser processing even the processing mechanism would be changed. Then the process is difficult to be controlled. Therefore the process of liquid-assisted laser machining should be detected. In order to better master and control this technology, many researchers have studied the existence of pressure in the process. And it has become a research hotspot in the field of laser composite processing. At present, most of the numerical simulation and experimental studies on the pulsation, shock wave, micro-jets and acoustic radiation of single bubble generated by single pulse laser are carried out. However, multi-bubble is usually produced in the process of liquid-assisted laser machining, which makes the phenomenon and the mechanism of laser processing become more complex. These complex phenomenon and mechanisms should be further explored and studied by researchers.

In this paper, the research status of pressure of shock wave and high speed micro-jet in liquid assisted laser machining has been reviewed. The mechanism of pressure generation and the basic characteristics of pressure are briefly resumed in liquid-assisted laser machining, the effects of laser energy, liquid viscosity, liquid surface tension, liquid gas content and the distance of laser focus on solid surface are summarized. And the detection methods of the impact pressure, such as shock wave and micro-jet are mainly introduced in the process of liquid assisted laser machining. And the characteristics of the detection methods, such as photography technology, optical deflection measurement method, hydrophone detection method and high frequency piezoelectric sensor detection method are summarized. Many researchers usually use two or more detection methods to study the distribution of the pressure field, the direction of the shock wave and the micro-jets, and the variation of pressure. Finally, the applications of liquid-assisted laser machining in micro-nano manufacturing, biomedicine and surface treatment are introduced and the prospects of the technology are summarized.

Keywords: liquid-assisted laser machining; pressure detection; shock wave; micro-jet

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