EFFECT OF MATERIAL THICKNESS ON DURATION, HOLE CHARACTERISTICS, AND DRILLING MECHANISM ON MICRO-LASER DRILLING

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I hereby declare that I have checked this thesis and, in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Kemajuan terkini dalam teknologi pembuatan telah menyumbang kepada pembangunan produk bersaiz micro dalam bidang automotif, aeroangkasa dan robotik. Proses ini melibatkan keamatan kuasa tinggi daripada laser untuk memecahkan ikatan antara molekul bahan kerja dan seterusnya membentuk lubang pada bahan kerja. Walau bagaimanapun, apabila ketebalan bahan meningkat, penghakisan bahan menjadi lebih sukar serta boleh menjejaskan ciri-ciri lubang dan tempoh proses yang diperlukan. Projek ini bertujuan untuk mengkaji kesan ketebalan bahan terhadap tempoh masa laser dan ciri-ciri lubang gerudi mikro yang dihasilkan. Penyelidikan ini juga bertujuan untuk menganalisis mekanisme pembentukan lubang semasa penggerudian mikro yang menggunakan laser sebagai medium utama. Bahan yang digunakan dalam penyelidikan ini ialah kepingan logam SS304 dengan tiga ketebalan berbeza, masing-masing 100µm, 200µm dan 300µm. Selain itu, mesin penanda laser, Herolaser ML-MF-A01 IPG dengan laser gentian 30-Watt telah digunakan. Hasil kajian menunjukkan saiz diameter lubang bagi setiap ketebalan bahan adalah malar sedikit bagi permukaan atas tetapi mempunyai nilai menurun pada permukaan bawah iaitu dalam julat 140.71µm-124.05µm. Sementara itu, tempoh yang diperlukan untuk menggerudi lubang untuk semua ketebalan bahan adalah antara 0.017s hingga 0.292s. Selain itu, ciri-ciri lain seperti tirus lubang, penyusunan semula bahan dan kekasaran permukaan mempunyai pengaruh terhadap perbezaan ketebalan bahan. Mekanisme pembentukan lubang secara umumnya terbahagi kepada dua fasa iaitu penggerudian yang masih belum menjadi tembus dan fasa seterusnya ialah apabila lubang telah ditebuk sehingga permukaan bawah. Secara keseluruhannya, tesis ini menunjukkan bahawa penggerudian mikro laser mungkin merupakan alternatif yang berpotensi untuk kaedah penggerudian mikro sedia ada kerana tempoh dan ciri lubang masih boleh dipertimbangkan. Tambahan pula, menganalisis pembentukan lubang mikro boleh memberikan pemahaman yang lebih baik tentang proses ini.

ABSTRACT

Recent advancement in manufacturing technology has led to the development of miniature products in the fields of automobiles, aerospace and robotics. This process involves high power intensity from the laser to break down the bond between molecules of the workpiece, hence forming a hole in the workpiece. However, as the material thickness increases, ablating away the material becomes more difficult and can affect the hole characteristics and the duration itself. This project aims to study the effect of material thickness on the laser duration and hole geometry of micro-drilled holes. This research also aims to analyse the mechanism of the hole formation during laser micro-drilling. The material used in this research is SS304 sheet metal with three different thicknesses, 100µm, 200µm and 300µm respectively. Besides, laser marking machine, Herolaser ML-MF-A01 IPG with 30-Watt fiber laser was used. The result showed that the size of the hole diameter for each material thickness is slightly constant for the top surface but has a decreasing value at the bottom surface which in range of 140.71µm-124.05µm. Meanwhile, the duration that needed to drill the hole for all the material thicknesses was in between 0.017s to 0.292s. In addition, the other characteristics such as hole taper, material redeposition and surface roughness have an influence on the differences in material thickness. The hole formation mechanism is generally divided into two phases, which is the drilling that has yet to be a 'through-hole' and the next phase is when the hole has been drilled until the bottom surface. Overall, this thesis demonstrates that laser micro-drilling may be a potential alternative to existing micro-drilling methods because duration and hole characteristics can still be considered. Furthermore, analysing the formation of the micro- hole may provide a better comprehension of this process.

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