

Experimental Investigation and Analysis of Laser Cutting Process Parameters

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Abstract— Laser cutting is one of the popular unconventional processes in which complicated shapes of various types of materials were being cut. This paper investigates the effects of parameters associated with CO₂ laser cutting process of aluminium plate because aluminium is difficult to cut using laser due to back reflection and low penetrating power of laser. The experiment was carried out on the basis of L₉ Taguchi's orthogonal array. The laser cutting parameters viz. laser power, cutting speed, assist gas pressure, and stand-off distance were arranged at three levels. It has been found that the quality of the cut edges and kerf are affected by laser power, cutting speed, assist gas pressure, and the stand-off distance. From the investigation it is found that the parameters such as laser power, cutting speed, stand-off distance have major impact on surface roughness and kerf width. Whereas, the effect of assist gas pressure over surface roughness and kerf width is less significant.

Keywords— CO₂ Laser, Laser power, Cutting speed, Assist gas pressure, Stand-off distance, Surface finish, and Kerf width.

I. INTRODUCTION

LASER stands for Light Amplification by Stimulated Emission of Radiation. Laser has a wide range of applications, ranging from military weapons to medical instruments. In industries laser is used as an unconventional method for cutting and welding. The main advantage of laser cutting is that, it is a non-contact operative method from which a good precise cutting of complicated shapes can be achieved. Also laser can be used to cut variety of materials like wood, ceramic, rubber, plastic and certain metals.

The most commonly used types of laser for laser cutting are CO₂ laser and Nd: YAG laser. CO₂ laser dominate this application due to their good quality beam combined to high output power and compared with other conventional mechanical processes, laser cutting removes little material, involves highly localized heat input to the workpiece thereby minimizing distortion and offers no tool wear. CO₂ laser has a wavelength of about 10.6µm due to this CO₂ laser has high power output when compared to Nd: YAG laser. Thus for cutting aluminum and aluminum based alloys CO₂ laser can be used.

In this paper, experimental work has been done to explore the influence of process parameters on the cut quality, such as: surface roughness and kerf width.

II. WORKING PRINCIPLE

Miroslav Radovanovic and Milos Madic [1] stated that laser beam is a high intensity beam of light that can be tightly focused onto a spot of only 0.1 to 0.2 mm in diameter. The high power density of the focused laser beam in the spot melts or evaporates material in a fraction of a second and the molten material is removed with a coaxial current of the assist gas as shown in Figure 1.

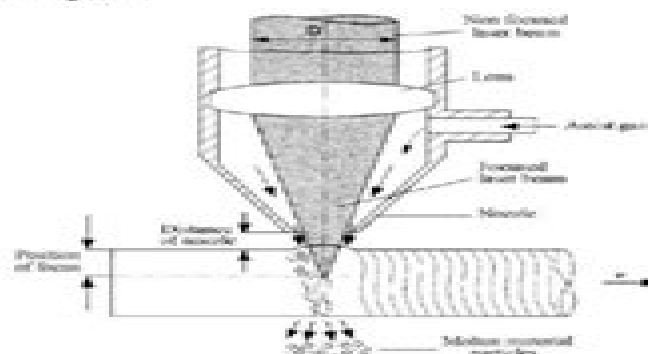


Figure 1. Laser beam cutting [1]

III. LITERATURE REVIEW

A. Surface roughness.

Surface roughness is an effective parameter representing quality of a machined surface. Thawari, G. et al. [2] observed that surface roughness value reduces with increase in cutting speed and frequency and decrease in laser power and gas pressure. Milos Madic et. al. [3] observed that the cutting speed should be kept at the highest level (7m/min), assist gas pressure at the lowest level (3 bar), while laser power should be kept at an intermediate level (0.9 kW) for obtaining minimal surface roughness. Sundar et al. [4] concluded the following: decrease in assist gas pressure shows a good decrease in surface roughness; higher cutting speed produces low surface roughness; there is a direct relation between the laser power and the surface roughness and the

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Zerspanungsmechanismen beim Schleifen von polykristallinem Diamant Florestan Schindler, 2015-11-12 Im Rahmen der Arbeit wurde ein Modell entwickelt welches die Mechanismen bei der schleifenden Bearbeitung von PKD grundlegend erklärt Das Kernstück der Untersuchungen bildete die erstmalig durchgeführte Analyse der PKD Randzone vor und nach dem Schleifen Aus den Ergebnissen wurde ein Modell für das PKD Schleifen aufgestellt welches die auftretenden Mechanismen auf der Basis der mechanischen und thermischen Prozessbelastung erklärt Darauf aufbauend wurde ein Optimierungsansatz gewählt bei dem die Effizienz der Endbearbeitung von PKD Werkzeugen durch die kombinierte Bearbeitung von Laserstrahlabtragen und Schleifen signifikant erhöht wurde

Experimental Investigations on Power Scaling of High-Brightness cw Ytterbium-Doped Thin-Disk Lasers Birgit Weichelt, 2021 *Experimental*

Investigations on Joining Techniques for Paper Structures Evgenia Kanli, 2021-08-26 The background of this research is related to innovative lightweight construction methods for short term applications realized with highly recyclable materials produced from renewable resources Specifically the possibility of using selected paper based products for design purposes is examined The main topic discussed regards the state of the art and future potential of joining techniques for assemblies and structures designed with paper based products In this context the preference on paper tubes for a variety of designs is examined closely A collection of case studies for selected joining techniques supported with digital tools fabrication of prototypes and targeted structural experiments demonstrates possibilities and considerations This book presents the research process and aims to inspire architects designers and engineers who are eager to discuss on material innovation and the steps that need to be taken to examine the feasibility of such ideas

Prozessgüte für das Laserstrahltrennen kohlenstofffaserverstärkter Kunststoffe Marten Canisius, 2017-11-09 Das Laserstrahltrennen kohlenstofffaserverstärkter Kunststoffe besitzt wegen der verschleiß- und kraftfreien Wirkungsweise technisches und wirtschaftliches Potential Die geringe technische Bearbeitungsgüte in Form einer Wärmeeinflusszone oder geringe Vorschubgeschwindigkeiten beim Trennen hemmen die Etablierung des Verfahrens Die Arbeit zeigt die Ursache für den primären Zielkonflikt zwischen der mittleren Breite der Wärmeeinflusszone und der effektiven Vorschubgeschwindigkeit beim Trennen mit mehrfacher Laserbelichtung auf In der Arbeit wird auf der Grundlage dieses Zielkonflikts eine Prozessgüte definiert die durch empirische und simulative Methoden optimiert wird Dazu wird eine werkstoffliche Modifikation zur Steigerung der Absorption der Laserstrahlung vorgenommen Zudem wird mittels numerischer Prozesssimulation und Optimierung die werkstoffliche Anpassung an den Laserprozess und insbesondere die abschnittsweise Anpassung der Prozessparameter untersucht Weiter wird ein Verfahren zur kontaktfreien Messung der Breite der Wärmeeinflusszone mittels Thermografie behandelt Die Ansätze werden an einem Automobilbauteil demonstriert

Laserstrahlabtragen von kubischem Bornitrid zur Endbearbeitung von Zerspanwerkzeugen Christian Daniel, 2019-04-29 Stähle hoher Festigkeit und Härte bieten Leichtbaupotential für

Anwendungen im Automobilbau sowie in der Energietechnik sie gehen jedoch zu den schwer zerspanbaren Werkstoffen Zur Fertigung leistungsfähiger Zerspanwerkzeuge aus polykristallinem kubischem Bornitrid PCBN eröffnet Laserstrahlabtragen mit kurzen und ultrakurzen Pulsen neue Potentiale Vor diesem Hintergrund erfolgt in der vorliegenden Arbeit die Erstellung eines methodischen Vorgehens zur Entwicklung von Laserstrahlabtragprozessen Dieses wird am Beispiel der Prozessentwicklung zur laserbasierten Fertigung von PCBN Werkzeugen mit geometrisch bestimmter Schneide validiert Die Anwendung des entwickelten Prozesses führt zum exemplarischen Einsatz der Werkzeuge in der Hartzerspanung

Advanced Engineering of Materials Through Lasers J. Radhakrishnan, Sunil Pathak, 2022-06-15 This book covers the fundamentals of different laser based manufacturing and processing namely laser shock peening laser micromachining laser cleaning cladding remelting laser honing and other several aspects of lasers The book discusses the general laser interaction with different materials The application of laser based post processing of additive manufacturing and repair engineering is reported It also provides the reader with mechanism of lasers in manufacturing and recent developments in tools technologies controls and operations

Mechanics of Composite and Multi-functional Materials, Volume 6 Piyush R. Thakre, Raman Singh, Geoff Slipper, 2025-08-07 Mechanics of Composite Hybrid and Multifunctional Materials Volume 6 of the Proceedings of the 2017 SEM Annual Conference Exposition on Experimental and Applied Mechanics the sixth volume of nine from the Conference brings together contributions to this important area of research and engineering The collection presents early findings and case studies on a wide range of areas including Nano Particulate Composites Recycled Constituent Composites Hybrid Composites Multifunctional Materials Fracture Fatigue of Composites Novel Developments in Composites Mechanics of Composites

The Laser Manufacturing Process Anooshiravan Farshidianfar, Seyedeh Fatemeh Nabavi, Mohammad Hossein Farshidianfar, 2024-08-21 The Laser Manufacturing Process is a comprehensive guide to industrial laser processes offering insights into their fundamentals applications across industries production specifics and characteristics including mechanical metallurgical and geometrical aspects as well as potential defects The book also investigates how industrial laser processes are developed and the diverse attributes of the resulting objects emphasizing their significance in industrial settings Here objects refer to the tangible outcomes of laser manufacturing encompassing a wide array of products and components created through processes like cutting welding and additive manufacturing These objects exhibit distinct mechanical properties metallurgical characteristics and geometrical precision all of which are crucial considerations in their utility and performance within industrial environments This book functions as a concise reference manual catering to the needs of both students and professionals who require knowledge related to laser manufacturing processes such as laser cutting laser welding and laser additive manufacturing processes

Mechanics of Composite, Hybrid and Multifunctional Materials, Volume 5 Piyush R. Thakre, Raman P. Singh, Geoffrey Slipper, 2025-08-07 Mechanics of Composite Hybrid and Multifunctional Materials Volume 5 of the Proceedings of the 2018 SEM Annual Conference

Exposition on Experimental and Applied Mechanics the fifth volume of eight from the Conference brings together contributions to this important area of research and engineering The collection presents early findings and case studies on a wide range of areas including Recycled Constituent Composites Nanocomposites Mechanics of Composites Fracture Fatigue of Composites Multifunctional Materials Damage Detection Non destructive Evaluation Composites for Wind Energy Aerospace Applications Computed Tomography of Composites Manufacturing Joining of Composites Novel Developments in Composites

Einfluss von Strahlformung auf Absorption, Fugenquerschnitt und Produktivität beim Laserschneiden Jannik Lind, 2024-11-22

Laser in der Technik / Laser in Engineering Wilhelm Waidelich, 2013-07-02 In den letzten Jahren haben Laseranwendungen in der Fertigungstechnik zunehmend an Bedeutung gewonnen Der seit 1973 in zweijährigem Turnus in München stattfindende internationale Kongress gibt in Verbindung mit der bedeutendsten internationalen Fachmesse der Optoelektronik einen Überblick über den aktuellen Stand in Forschung Technik und Medizin In Fortsetzung dieser Tradition vermittelt der 11. Internationale Kongress LASER 93 neue Erkenntnisse aus Grundlagenforschung Entwicklung und Anwendung in der Praxis Um dem breitgefächerten Interessensspektrum von Forschern Ingenieuren und industriellen Anwendern Rechnung zu tragen wurde der Kongress in neun Fachkongresse unterteilt Der Band *Laser in der Technik* umfasst folgende Themenkreise Moderne Festkörperlaser Optische Messtechnik und Präzisionstechnik Laser in der Fertigung Optoelektronische Komponenten und Systeme Laser in der Forschung Microsensorik und Faseroptik Optische Kommunikation und Informationsübertragung

Scientific and Technical Aerospace Reports, 1994

Innovative Development in Micromanufacturing Processes Pawan Kumar Rakesh, J. Paulo Davim, 2023-11-23

Innovative Development in Micromanufacturing Processes details cutting edge technologies in micromanufacturing processes an industry which has undergone a technological transformation in the past decade Enabling engineers to create high performance low cost and long lasting products this book is an essential companion to all those working in micro and nano engineering As products continue to get smaller and smaller the field of micromanufacturing has gained an international audience This book looks at both approaches of micromanufacturing top down and bottom up The top down approach includes subtractive micromanufacturing processes such as microturning micromilling microdrilling laser beam micromachining and magnetic abrasive finishing The bottom up approach involves additive manufacturing processes such as micro forming micro deep drawing microforging microextrusion and microwelding Additionally microjoining and microhybrid manufacturing processes are discussed in detail The book also aids engineers and students in solving common manufacturing issues such as choice of materials and testing The book will be of interest to those working in micro and nano engineering and machining as well as students in manufacturing engineering materials science and more

Advances in Machining of Composite Materials Islam Shyha, Dehong Huo, 2021-06-21 This book covers a wide range of conventional and non conventional machining processes of various composite materials including polymer and metallic based composites

nanostructured composites and green natural composites It presents state of the art academic work and industrial developments in material fabrication machining modelling and applications together with current practices and requirements for producing high quality composite components There are also dedicated chapters on physical properties and fabrication techniques of different composite material groups The book also has chapters on health and safety considerations when machining composite materials and recycling composite materials The contributors present machining composite materials in terms of operating conditions cutting tools appropriate machines and typical damage patterns following machining operations This book serves as a useful reference for manufacturing engineers production supervisors tooling engineers planning and application engineers and machine tool designers It can also benefit final year undergraduate and postgraduate students as it provides comprehensive information on the machining of composite materials to produce high quality final components The book chapters were authored by experienced academics and researchers from four continents and nine countries including Canada China Egypt India Malaysia Portugal Singapore United Kingdom and the USA CAD/CAM, Robotics and Factories of the Future Dipak Kumar Mandal, Chanan Singh Syan, 2016-01-05 This volume is based on the proceedings of the 28th International Conference on CAD CAM Robotics and Factories of the Future This book specially focuses on the positive changes made in the field of robotics CAD CAM and future outlook for emerging manufacturing units Some of the important topics discussed in the conference are product development and sustainability modeling and simulation automation robotics and handling systems supply chain management and logistics advanced manufacturing processes human aspects in engineering activities emerging scenarios in engineering education and training The contents of this set of proceedings will prove useful to both researchers and practitioners Advanced Engineering Research (IFMME) Yun Hae Kim, 2014-04-09 Selected peer reviewed papers from the 2014 2nd International Forum on Mechanical and Material Engineering IFMME 2014 March 8 9 2014 Zhuhai China **Advanced Modeling and Optimization of Manufacturing Processes** R. Venkata Rao, 2010-12-01 Advanced Modeling and Optimization of Manufacturing Processes presents a comprehensive review of the latest international research and development trends in the modeling and optimization of manufacturing processes with a focus on machining It uses examples of various manufacturing processes to demonstrate advanced modeling and optimization techniques Both basic and advanced concepts are presented for various manufacturing processes mathematical models traditional and non traditional optimization techniques and real case studies The results of the application of the proposed methods are also covered and the book highlights the most useful modeling and optimization strategies for achieving best process performance In addition to covering the advanced modeling optimization and environmental aspects of machining processes Advanced Modeling and Optimization of Manufacturing Processes also covers the latest technological advances including rapid prototyping and tooling micromachining and nano finishing Advanced Modeling and Optimization of Manufacturing Processes is written for designers and manufacturing engineers who are

responsible for the technical aspects of product realization as it presents new models and optimization techniques to make their work easier more efficient and more effective It is also a useful text for practitioners researchers and advanced students in mechanical industrial and manufacturing engineering

International Conference on Emerging Trends in Engineering (ICETE) Suresh Chandra Satapathy,K. Srujan Raju,Kumar Molugaram,Arkanti Krishnaiah,George A.

Tsihrintzis,2019-07-26 This book constitutes the proceedings of the First International Conference on Emerging Trends in Engineering ICETE held at University College of Engineering and organised by the Alumni Association University College of Engineering Osmania University in Hyderabad India on 22 23 March 2019 The proceedings of the ICETE are published in three volumes covering seven areas Biomedical Civil Computer Science Electrical Electronics Electronics Communication Mechanical and Mining Engineering The 215 peer reviewed papers from around the globe present the latest state of the art research and are useful to postgraduate students researchers academics and industry engineers working in the respective fields This volume presents state of the art technical contributions in the areas of civil mechanical and mining engineering discussing sustainable developments in fields such as water resource engineering structural engineering geotechnical and transportation engineering mining engineering production and industrial engineering thermal engineering design engineering and production engineering

Angiography Burak Pamukçu,2019-06-19 Atherosclerotic cardiovascular disease is still the most common cause of death among adults Its prevalence is increasing in developing countries and despite all advances in both diagnostic tools and treatment modalities it is still very common in the developed world Obesity diabetes mellitus hypercholesterolemia and overuse of dietary salt play a pivotal role in increased cardiovascular morbidity and mortality worldwide Current clinical efforts are mainly focused on the diagnosis and treatment of myocardial infarction In this book we provide epidemiological data on myocardial infarction and atherosclerotic cardiovascular disease current diagnostic biochemical tests and management strategies A specific patient group children experiencing myocardial infarction is also addressed Current advancements in the management of myocardial infarction have decreased the morbidity and mortality from atherosclerotic cardiovascular disease and especially myocardial infarction however further progress can be achieved by the prevention of atherosclerotic processes by focusing on the early stages of the disease

Biomedical Devices Tugrul Özel,Paolo Jorge Bártolo,Elisabetta Ceretti,Joaquim De Ciurana Gay,Ciro Angel Rodriguez,Jorge Vicente Lopes Da Silva,2016-09-13 Biomedical Devices Design Prototyping and Manufacturing features fundamental discussions of all facets of materials processing and manufacturing processes across a wide range of medical devices and artificial tissues Represents the first compilation of information on the design prototyping and manufacture of medical devices into one volume Offers in depth coverage of medical devices beginning with an introductory overview through to the design manufacture and applications Features examples of a variety of medical applications of devices including biopsy micro forceps micro needle arrays wrist implants spinal spacers and fixtures Provides students doctors scientists and technicians

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