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Study of Laser Physics and its Applications

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ABSTRACT

In the engineering business, materials are prepared by standard techniques as cutting, drilling, milling, grinding etc., and by non standard methods like EDM, EBM, Abrasive water jet machining, laser beam machining etc. Various processing strategies are used to collection the manufacturing must have. Standard techniques are utilized in case expense of first purchase, quickness of processing the substance, accuracy, precession along with other associated variables is bearable. If not non standard methods are used. Of all the non standard techniques, Laser material processing is a crucial technique locating application in Defence, Aerospace, Medical equipment along with other high tech industries as they are able to offer freedom, effective content consumption along with a repeatable, process that is controlled. This particular report is about an organized parametric research of material removal rates, characterisation of laser cut exterior along with a technique to produce a powerful style for the task analysis to foresee the perfect practice parameter values for slicing of 304 quality stainless utilizing a top energy co2 laser. The job of this particular thesis helps you to boost the task preparing choices of laser machining of 304 quality stainless steel for the optimum programs of its as well as automation in manufacturing.

1. Introduction

A laser beam is an unit which emits electromagnetic radiation by way of a a procedure for optical amplification according to the stimulated emission of photons. Lasers are devices which produce extreme beams of light that are highly, coherent, and monochromatic collimated. The wavelength of laser light is very clean in comparison with various other sources of light and every one of the photons which form the laser beam employ a fixed stage connection with regard to each other. Light from a laser generally has really low divergence. It is able to go more than great distances or perhaps may be concentrated to a tiny area with a brightness that exceeds that of the sunshine. Due to these attributes, lasers are utilized in a number of applications in all areas of life. A simple understanding of a principle aids in understanding the laser unit. Figure-1 reveals that electromagnetic radiation is produced anytime a charged particle like an electron provides up energy. This occurs each time an electron drops out of a greater power state, Q1, to a reduced power state, Q0, in an atom or

maybe ion as happens in a fluorescent light. This likewise happens from changes of the rotational or vibrational state of molecules. The style of light is driven by its wavelength or frequency. The shorter wavelengths are definitely the ultraviolet and also the longer wavelengths will be the infrared. Probably The smallest particle of light energy is discussed by quantum mechanics as being a photon1. Laser beam is an effective supply of light owning remarkable properties that are not present in the standard light energy sources as tungsten lamps, mercury lamps, etcetera. The special property of laser is the fact that the light waves of its travel long distances with e hardly any divergence. In case of a standard e source of light, the light is produced to a jumble of e different waves which cancel one another at random and therefore could journey extremely limited distances only.

2. Applications of lasers

Laser is an optical unit which yields extreme beam of coherent monochromatic light by stimulated emission of radiation.

Laser light differs from a regular light. It's different unique properties for example coherence, directionality, monochromacity, and intensity that is high. Due to these unique qualities, lasers are utilized in numerous applications.

Lasers in Medicine

- Lasers are utilized for bloodless surgery.
- Lasers are used-to eliminate kidney stones.
- Lasers are utilized in therapy and cancer diagnosis.
- Lasers are utilized for eye lens curvature corrections.
- Lasers are utilized in fiber optic endoscope to discover ulcers in the intestines.
- The lung and liver diseases might be addressed by using lasers.
- Lasers are used-to learn the inner structure of cells and microorganisms.
- Lasers are used-to create chemical reactions.
- Lasers are utilized to generate plasma.
- Lasers are used-to eliminate tumors successfully.
- Lasers are utilized to eliminate the caries or decayed part of the tooth.
- Lasers are utilized in cosmetic treatments including acne treatment, hair removal and cellulite.

Lasers in Communications

- Laser light is utilized in optical fiber communications to post info over big distances with lower loss.
- Laser light is utilized in underwater telecommunications networks.

- Lasers are utilized in space communication, and radars satellites.

Lasers in Industries

- Lasers are used to cut quartz and glass.
- Lasers are used in electric powered industries for trimming the components of Integrated Circuits (ICs).
- Lasers are used for heat treatment in the car business.
- Laser light is used to collect the information about the prefixed costs of items that are different in shops along with business businesses in the bar code printed on the product.
- Ultraviolet lasers are employed in the semiconductor industries for photolithography. Photolithography is the method used for creating printed circuit board (Pcb and Microprocessor) by utilizing uv light.
- Lasers are used to drill aerosol nozzles and control orifices inside the required precision.

Lasers in Science and Technology

1. A laser beam helps in learning the Brownian motion of particles.
2. With the assistance of a helium neon laser, it was demonstrated the velocity of light is exact same in all directions.
3. With the assistance of a laser, it's doable to count the number of atoms in a substance.
4. Lasers are utilized in computer systems to access saved info from a small Disc (CD).
5. Lasers are used-to store massive amount of information or info in CD ROM.
6. Lasers are used-to calculate the pollutant gases along with other contaminants of the environment.
7. Lasers help in identifying the speed of rotation of the planet accurately.
8. Lasers are utilized in computer printers.
9. Lasers are utilized for creating three dimensional photographs in garden without using lens.
10. Lasers are utilized for detecting earthquakes and underwater nuclear blasts.
11. A gallium arsenide diode laser could be utilized to setup an invisible fence to defend an area.

Lasers in Military

1. Laser range finders are utilized to identify the distance to an item.
2. The ring laser gyroscope is utilized for realizing and measuring tiny perspective of rotation of the moving objects.
3. Lasers could be utilized as secretive illuminators for reconnaissance during evening with top accuracy.
4. Lasers are used-to dispose the power of a warhead by harming the missile.
5. Laser light is utilized in LIDAR's to effectively assess the distance to an item.

3. 3. Laser in material processing

Laser is an intense source of electromagnetic radiation which is highly monochromatic and coherent. This property makes it as an important non-conventional cutting tool in manufacturing engineering. The demand for high productivity and high quality has given rise to laser based methods of material processing. In manufacturing processes the lasers serve as devices capable of applying extremely high flux of energy on the surface of a work piece. In this aspect lasers have a distinct advantage over the conventional heat sources like flame cutters, Gas cutters, arc cutting, and plasma jets.

Lasers beam is a very pure stream of photons all going in the same direction. For a fixed wavelength, the laws of physics tell us that all the photons have the same energy. For a shorter wavelength beam, the energy of each photon is higher. So what happens on an atomic scale when this stream of pure light or photons are absorbed by a surface? Usually, the energy is converted into vibration of the atoms which in effect heats up the surface, although in some cases this can be on the scale of a few thousandths of a millimeter (or microns). Under certain very special conditions these photons may, if their energy is high enough, break an atomic bond. The majority of laser processes are however, thermal in nature; they are the result of the generation of very well controlled melting and vaporization processes. Most importantly, the laser is controllable both spatially and temporally; that is to say we can control exactly where and when the heat is being put in to the target. Once an applications engineer establishes the method to perform a particular process, the reliability and repeatability of the laser should ensure that the process does not change.

Another approach to understand laser processing is to consider only the processes that can occur when a laser beam strikes a surface. For all electromagnetic beam, a beam striking on the surface is either reflected or absorbed or transmitted. Expressed very simply: Reflection + Absorption + Transmission = 1. In almost all practical situations, some of all three processes occur. It is the absorption of beam which is of importance for processing applications. All laser processes can be considered in this way, and our understanding of many of the phenomena of laser processing can be helped by this approach. If we assume that a significant proportion of the beam is absorbed by the target, then the three dominating factors namely average power of the laser beam, intensity of the laser spot on the target and the wavelength of the laser beam will play an important role in processing applications. Hence of the several laser developed only a few are of interest for industrial applications.

4. 4. Results & discussion

4.1 Fem Model to Study Temperature Distribution During Laser Cutting Of Stainless Steel

In laser material processing normally the laser beam heats up and melts, occasionally evaporates the effort slice in a tiny area mostly provided by the focal area. This heat is absorbed largely by the surface area of the material. The temperature reached for a certain heat input per device volume decreases with increasing certain density and heat. And so the heat lastly reached on the surface area of the efforts portion in addition to interior around the prepared track is primarily provided by the processing speed, the winter qualities of the work piece and the thickness of its. Clearly the optimum temperature is obtained at that time in which the laser beam hits the function piece, lessening constantly in lateral guidance in a co ordinate system going together with the beam with regard to the work piece. In the path of family

member motion among beam as well as career portion the laser beam hits regions which had not originally been heated, therefore strong heat conduction takes place along with a big temperature gradient is found in the level of cut. The climate division in the content is very critical since the quality of heating decides the development of microstructure of the efforts portion, the heat affected zone as well as the processing quality.

Estimation of climate distribution inside the work portion material can be accomplished analytically and by numerical computation programs. The very first analytical item on the principle of shifting heat supply was provided by Rosenthal D [1946].But the temperature reliant Thermo physical qualities of the content, the concerns in the portion absorption of the laser beam energy by the efforts portion along with other physical problems in the laser beam material interaction complicates the calculation of the heat division. In order to overcome these difficulties to some degree, numerical computational techniques like finite component method (FEM) is needed rather than analytical techniques. Nevertheless the accessible published outcomes on limited component technique learning the heat division in slicing of stainless steel 304 using Laser beam is incredibly minimal.

4.2 Modelling using FEM

To us the business ANSYS program, the limited component version for the laser cutting of stainless steel 304 is made based on the mechanical and thermal boundary situations throughout cutting. The unit will be given to the cut information, stainless steel by determining the actual physical qualities of its including Young s modulus, Thermal conductivity, Specific Heat capability, density, etc. After that the content is split into smaller elements as well as nodes (Tetrahedron) for the use of limited component evaluation. The mesh is twenty noded brick component. Figure one illustrates the strong modelling of the analysis.

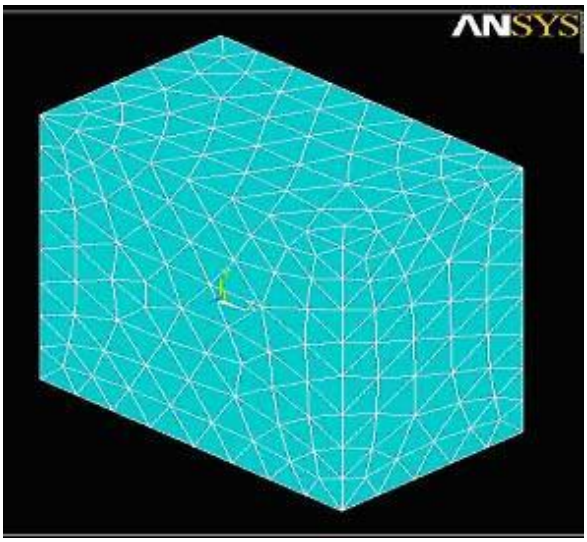

Figure 1: 3-Dimensional Model of work piece meshed with Thermal solid 20 noded Brick element

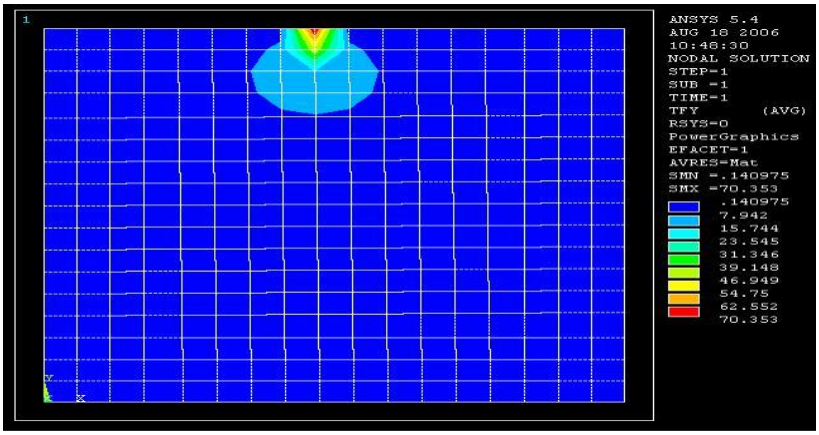

Figure2: Temperature distribution along the laser beam direction (nodal solution) in cutting stainless steel by CO_2 laser

A heating flux corresponding to laser energy of 1600 watts is used to the good design by producing the necessary working conditions for laser cutting of stainless steel. The answer uncovers the temperature distributions at different nodes along X direction as well as Y-direction. The output out of the limited component unit suggests that heat is absorbed largely in the counter in which the beam hits the components top. Figure two shows the nodal option evaluation for the heat division around the Laser beam direction. Figure two shows the temperature division perpendicular to the beam path whenever the analysis is completed for nodal fix.

The elemental option for the temperature distribution additionally correlates the outcomes obtained for the nodal fix.

Figure four shows the heat division for the elemental option within transverse path to the laser beam. The form of the heat division stretches much more into the level of the content in contrast to the extension in the horizontal path. The level of the climate gradient may be managed efficiently by modulating the laser beam power. This can manage the Heat affected zone as well as likely deteriorations due to thermal consequences as well as strains which could create.

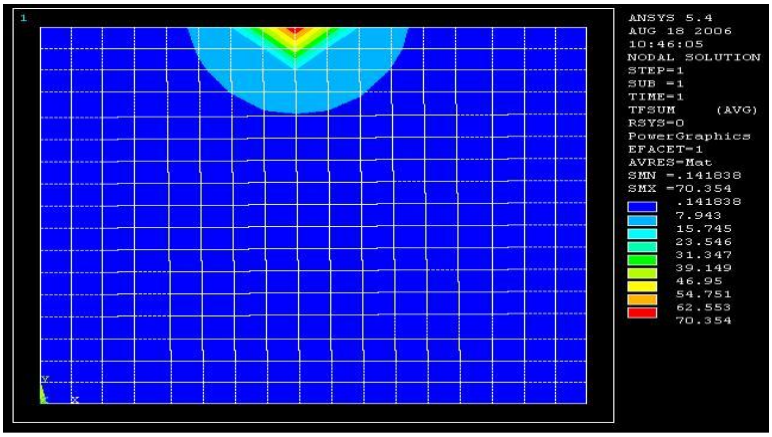

Figure 3: Temperature distribution perpendicular to the laser beam direction (nodal solution) in cutting stainless steel by CO_2 laser

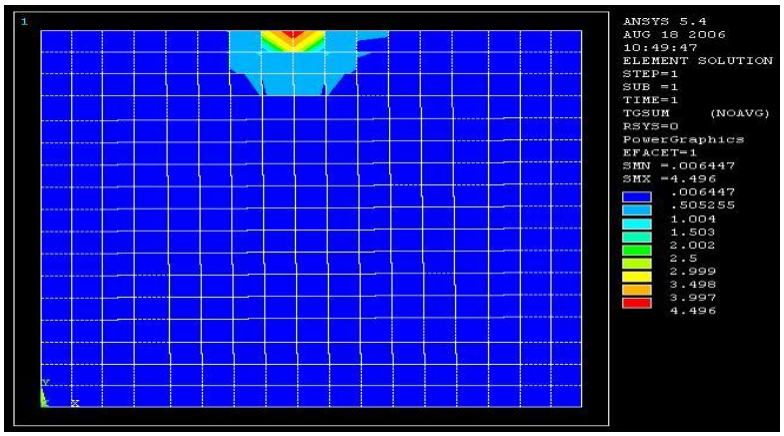

Figure 4: Temperature distribution along perpendicular direction to the laser beam direction. (Elemental solution) in cutting stainless steel by CO_2 laser

From these ways because of the heat distribution, it could be found the heat affected zone is limited and it is tiny in cutting stainless steel by CO2laser. This's in agreement with the experimental outcomes with metallurgical along with SEM scientific studies as talked about during the early chapters in laser cutting of stainless steel 304.

5. Conclusion

A laser beam is a unit which emits electromagnetic radiation by way of aaprocedure for optical amplification according to the stimulated emission of photons. The wavelength of laser light is very clean in comparison with various other sources of light and every one of the photons which form the laser beam employ a fixed stage connection with regard to each other. Laser beam is an effective supply of light owning remarkable properties that are not present in the standard light energy sources as tungsten lamps, mercury lamps, etcetera. The special property of laser is the fact that the light waves of its travel long distances with e hardly any divergence. The laser is an analogous to a spring which is wound up and also cocked, it really needs the key to put out, in the key and this procedure will be the photon owning precisely the identical wavelength as that of the lighting to be produced. As an unit, lasers are utilized in medicine, astronomy, geodesy, metrology, chemistry, biology, spectroscopy, holography, power engineering, in different tasks in engineering and in communication technology, remote control and automation, for military technology, art restorations, entertainment industry, etcetera.

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