

A Study on Laser Beam Machining

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ABSTRACT: Applications of laser are increasing in manufacturing industries. Laser material processing has become a profitable alternative to conventional manufacturing technologies and cost-effective tools for producing intricate components. In Laser Material Processing, laser must be powerful for material processing. Gas lasers, solid-state lasers, and semiconductor lasers are commonly used. These lasers are often used for cutting, welding, surface heating, melting, texturing, roughening, marking, and cleaning. In laser cutting, finish cut quality can be achieved in single process; the cutting kerf is very small. Sharp angles, small radius rounds and complex curves can be cut with high speed and flexibility small heat affected zone exists for laser cutting, but it is of micron scale, which means negligible thermal and mechanical distortions. For thin layers (<20mm) laser cutting of many materials is a faster and high quality process compared with other processes. Thick section cutting and high speed cutting need special consideration.

KEYWORDS: Stimulated laser, laser cutting, laser drilling, laser welding..

I. INTRODUCTION

In today's competitive world we need highly skilled people, speed of manufacture, accuracy, time to market or a technological edge to reduce the operations cost. In recent years the increase in laser cutting is replacing more conventional mechanical processes due to increased flexibility. The improvements in accuracy, edge square ness and heat input control means that other profiling techniques such as plasma cutting and oxy-fuel cutting are being replaced by laser cutting.

LASER is a short form of Light Amplification by Stimulated Emission of Radiation. Lasers are devices that amplify light and produce coherent light beams, ranging from infrared to ultraviolet. A light beam is coherent when its waves, or photons, propagate in step, or in phase, with one another. Laser light, therefore, can be made extremely intense, highly directional, and very pure in color .

II. PRINCIPLES OF OPERATION

Lasers bind the atoms, to store and emit light in a coherent fashion. The electrons in the atoms of a laser medium are first energized to an excited state by an energy source. They are then "stimulated" by external photons to emit the stored energy in the form of photons, a process known as stimulated emission. The photons emitted have a frequency characteristic of the atoms and travel in step with the stimulating photons. These photons in turn impinge on other excited atoms to release more photons. Light amplification is achieved as the photons move back and forth between two parallel mirrors, triggering further stimulated emissions, as shown in figure below. At the same time the intense, directional, and monochromatic laser light "leaks" through one of the mirrors, which is only partially silvered.

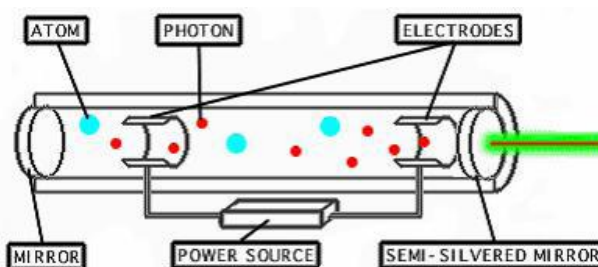


Figure 1: Schematic diagram of production of laser beam

III. LASER PROCESSING

Laser Processing is defined as the ability to accurately and reliably control the amount of energy delivered by the laser as well as the location to which it is delivered. This is easily accomplished using computer control. Programming and importing files into these systems is the same as using a CNC machine. Once the pattern to be processed is imported into the system from the computer control, the laser's operating parameters can be adjusted depending on the type of material being processed and whether it is to be cut, kiss-cut, perforated etc. An on-board microprocessor continuously monitors the actual cutting speed and dynamically adjusts the laser power as the speed changes. Laser processing permits the design of complex shapes and parts that are difficult to manufacture using other methods. With a focused spot size as small as 0.005 inches (speed as high as 600 in/min) these systems allow parts with intricate detail and sharp corners to be produced quickly and accurately.

IV. LASER USED IN MANUFACTURING

A laser is a non-contact tool that does not wear out. It delivers enormous amounts of light energy to precise locations without ever physically touching the object being processed. This energy can be used to cut, perforate, weld, scribe or drill materials depending on the wavelength of light emitted by the laser, its fluence (energy per unit area), the duration of the emission, and the properties of the material being processed. Although many types of lasers can be used for materials processing, a CO₂ laser emits an infrared beam of light at a wavelength of 10.6 μ m, which has been found to be highly effective in processing paper products, metals, adhesives, acrylics, polyester, and polycarbonates. In Laser Material Processing, a laser must be reasonably powerful for material processing. Gas lasers, solid-state lasers, and semiconductor lasers are commonly used. These lasers are often used for cutting, welding, surface heating, melting, alloying, texturing, marking, cleaning.

V. LASER MACHINING

In Laser machining processes metal is removed by melting and blow away, or by direct vaporization. On the other hand, traditional machining processes rely on mechanical stresses induced by tools to break the bonds of materials. Some commonly used applications are

Laser cutting:

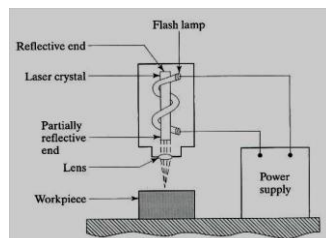


Figure 2: Schematic diagram of laser cutting

Laser cutting is suitable for thin work pieces because of its noncontact feature. Laser cutting is a mostly thermal process in which a focused laser beam is used to melt material in a localized area. A continuous cut is produced by moving the laser beam or workpiece under CNC control. Lasers have been used to cut a wide range of materials. CO₂ laser is the most popular laser in cutting, it can provide high powers (above 1 KW) for high speed cutting. Laser cutting can be basically divided into two kinds:

Evaporative Laser Cutting:

In this laser provides the latent heat until the material reaches vaporization point and convert it into vapor state, such as laser cutting of organic materials--paper, cloth or polymers having poor thermal conductivity.

Melting or Fusion Cutting:

Laser energy melts the target material and the gas jet blows the molten material away. The requirement of laser energy is lower compared with evaporative cutting. In laser cutting, cut edge should be sufficiently clean and smooth, finish cut quality can be achieved in single process, the cutting kerf is very small. Sharp angles, small radius rounds and complex curves can be cut with high speed and flexibility. Edge burr and dross adhesion can be avoided. A small heat affected zone exists for laser cutting, but it is of micron scale, which means negligible thermal and mechanical distortions. For thin layers (<20mm) laser cutting of many materials is a faster and high quality process compared with other processes. Thick section cutting and high speed cutting need special considerations. Laser beam fusion cutting with nitrogen as cutting gas avoid oxidation of the cut surface. As the cutting speed increases the kerf width decreases and the flank angle increases.

MERITS AND DEMERITS OF LASER PROCESSING

Merits:

- 1) It is possible to drill 'micro' holes with very large depth-to-diameter ratios with high accuracy.
- 2) The properties of heat-treated material or magnetic material are not affected by laser beam machining, so there is a very negligible heat affected zone.
- 3) There is no tool wear or any tool breakage involved in this process.
- 4) Any metal or nonmetal can be easily machined by this process.
- 5) No burrs are produced in this process.
- 6) The process has the ability to drill in inaccessible locations.
- 7) It is possible to drill at shallow angles (15°) by this process.
- 8) Lasers have high processing speeds.

Demerits:

- 1) The metal removal rate of 0.0065 cm³ / hour in LBM is by far the slowest as compared to other machining process.
- 2) The holes produced by LBM (Laser Beam Manufacturing) may taper from entry to exit. The taper on one side of the hole can be much as 0.05 mm/mm.
- 3) Circular holes produced by LBM are restricted to 3.20 mm in diameter in material thickness not exceeding 12.5 mm
- 4) LBM results in a series of ridges along the edge of the working when laser is used for cutting. This is due to metal freezing on the sides of the hole.
- 5) Capital is intensive in laser processing and requires special trained operators.

VI. CONCLUSION

It is now entirely possible that metal parts will be manufactured and there won't be any cutting tools involved. Beside simple parts, even complex, contoured items will be produced through the implementation of laser technology. More smooth, precise, and clean cuts can be created Worldwide most of the laser is installed in the automotive industry, 60 percent of them are used for laser welding and 40 percent of them are used for laser beam machining. The annual increase is about 20 percent. More than half of all Laser machines used in automotive industry are placed in Japan, most of them equipped with CO₂ lasers. Even though this technique is new to India and most of the laser work done is for welding application, laser machining is in beginning stage in India. Indian industries are now looking forward to laser machining process. With the developing infrastructure and technology we would see a new era of non conventional machining. Though these techniques demand considerable initial investments but they have the edge over conventional machining in terms of speed, accuracy, complexity, etc. With new developments laser beam machining is becoming more versatile for industrial applications. Applications are abundant in a variety of fields.

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