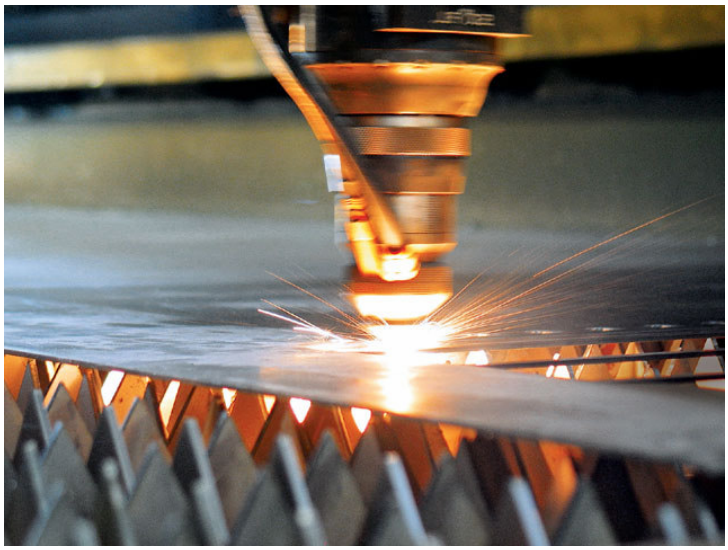
Introduction



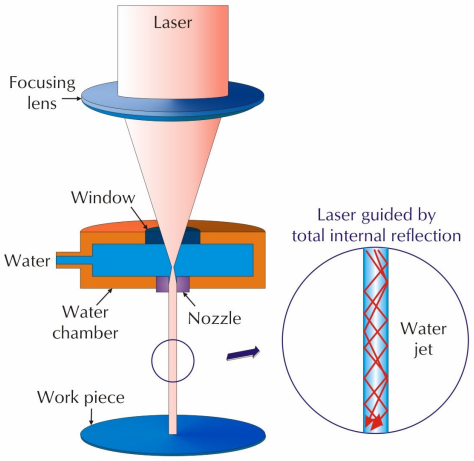
Learning Objectives

On completion of this topic you will be able to:

1. Applications of Lasers in cutting and welding
2. Applications of Lasers Laser in heat treatment
3. Applications of Lasers Laser in Medical applications
4. Applications of Lasers Holography (construction & reconstruction)

Laser cutting and Welding

Laser cutting is a technology that uses a laser to cut materials, and is typically used for industrial manufacturing applications. Laser cutting works by directing the output of a high power laser, by computer, at the material to be cut. The material then either melts, burns, vaporizes away, or is blown away by a jet of gas, leaving an edge with a high quality surface finish. Industrial laser cutters are used to cut flat-sheet material as well as structural and piping materials.

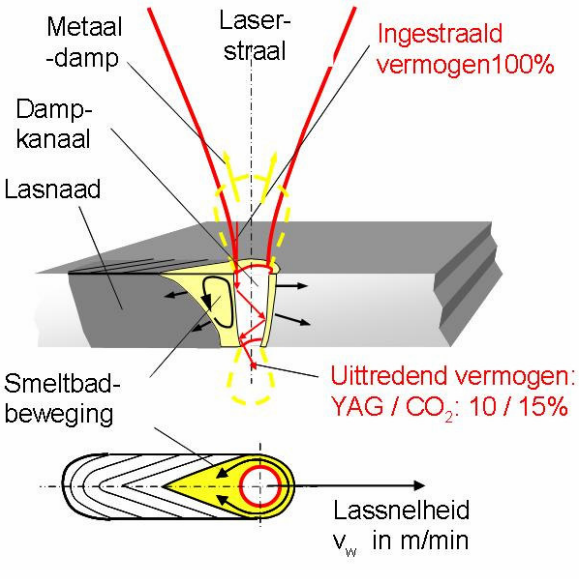


Both gaseous CO_2 and solid-state Nd:YAG lasers are used for cutting, in a ddition to welding, drilling, surface treatment, and marking applications.

Laser cutters usually work much like a milling machine would for working a sheet in that the laser (equivalent to the mill) enters through the side of the sheet and cuts it through the axis of the beam. In order to be able to start cutting from somewhere else than the edge, a pierce is done before every cut. Piercing usually involves a high power pulsed laser beam which slowly (taking around 5-15 seconds for half-inch thick stainless steel, for example) makes a hole in the material.

Laser beam welding (LBW) is a welding technique used to join multiple pieces of metal through the use of a laser. The beam provides a concentrated heat source, allowing for narrow, deep welds and high welding rates. The process is frequently used in high volume applications, such as in the automotive industry.

A continuous or pulsed laser beam may be used depending upon the application. Milliseconds long pulses are used to weld thin materials such as razor blades while continuous laser systems are employed for deep welds.



LBW is a versatile process, capable of welding carbon steels, HSLA steels, stainless steel, aluminum, and titanium. Due to high cooling rates, cracking is a concern when w elding high-carbon steels. The weld quality is high, similar to that of electron beam welding. The speed of welding is proportional to the amount of power supplied but also depends on the type and thickness of the workpieces. The high power capability of gas lasers make

them especially suitable for high volume applications. LBW is particularly dominant in the automotive industry.

Some of the advantages of LBW in comparison to EBW are as follows: the laser beam can be transmitted through air rather than requiring a vacuum, the process is easily automated with robotic machinery, x-rays are not generated, and LBW result in higher quality welds.

Lasers in heat treatment

Laser cooling

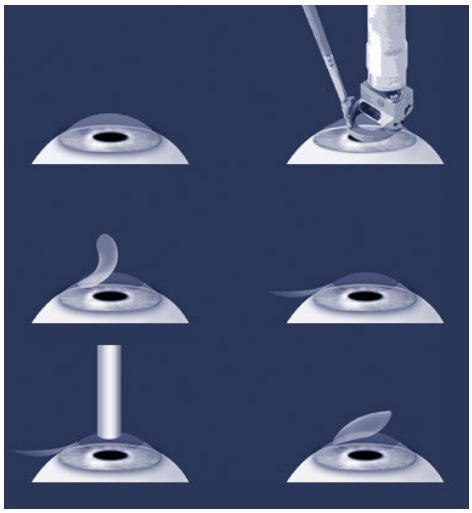
A technique that has had recent success is *laser cooling*. This involves atom trapping, a method where a number of atoms are confined in a specially shaped arrangement of electric and magnetic fields. Shining particular wavelengths of laser light at the ions or atoms slows them down, thus *cooling* them. As this process is continued, they all are slowed and have the same energy level, forming an unusual arrangement of matter known as a Bose-Einstein condensate.

Nuclear fusion

Some of the world's most powerful and complex arrangements of multiple lasers and optical amplifiers are used to produce extremely high intensity pulses of light of extremely short duration. These pulses are arranged such that they impact pellets of tritium-deuterium simultaneously from all directions, hoping that the squeezing effect of the impacts will induce atomic fusion in the pellets. This technique, known as "inertial confinement fusion", so far has not been able to achieve "breakeven", that is, so far the fusion reaction generates less power than is used to power the lasers, but research continues.

Lasers in Medical Treatment

Lasers used in cosmetic surgery (removing tattoos, scars, stretch marks, sunspots, wrinkles, birthmarks, and hairs. Laser types used in dermatology include ruby (694 nm), alexandrite (755 nm), pulsed diode array (810 nm), Nd:YAG (1064 nm), Ho:YAG (2090 nm), and Er:YAG (2940 nm).
Lasers used in Eye surgery:



- LASIK (laser vision correction) - (*laser-assisted in situ keratomileusis*) is a popular elective refractive laser eye surgery performed by ophthalmologists for the correction of myopia, hyperopia, and astigmatism

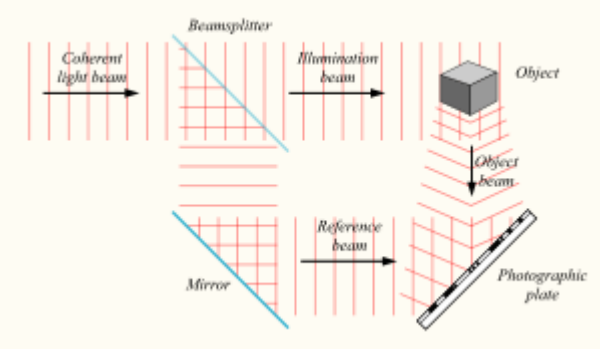
- LASEK (laser-assisted sub-epithelial keratectomy or Laser Epithelial Keratomileusis) are laser eye surgery procedures intended to correct a person's vision, reducing dependency on glasses or contact lenses

Lasers used as blades in general surgery - Laser scalpel (General surgery, gynecological, urology, laparoscopic) - A laser scalpel is a scalpel for surgery, cutting or ablating living biological tissue by the energy of laser light. In soft tissue laser surgery, a laser beam ablates or vaporizes the soft tissue with the high water content

Lasers used in Dental treatment.

Holography

Holography (from the Greek *hòlòs* whole + *grafè* writing, drawing) is a technique that allows the light scattered from an object to be recorded and later reconstructed so that it appears as if the object is in the same position relative to the recording medium as it was when recorded. The image changes as the position and orientation of the viewing system changes in exactly the same way as if the object were still present, thus making the recorded image (hologram) appear three dimensional. Holograms can also be made using other types of waves.



The technique of holography can also be used to optically store, retrieve, and process information. While holography is commonly used to display static 3-D pictures, it is not yet possible to generate arbitrary scenes by a holographic volumetric display

Applications of Holography

Holography can be put to a variety of uses other than recording images. **Holographic data storage** is a technique that can store information at high density inside crystals or photopolymers. The ability to store large amounts of information in some kind of media is of great importance, as many electronic products incorporate storage devices.

Security holograms are very difficult to forge because they are replicated from a master hologram which requires expensive, specialized and technologically advanced equipment. They are also used in credit and bank cards as well as quality products.

Holographic interferometry is a technique which enables static and dynamic displacements of objects with optically rough surfaces to be measured to optical interferometric precision (i.e to fractions of a wavelength of light). It can also be used

to detect optical path length variations in transparent media, which enables, for example, fluid flow to be visualised and analysed. It can also be used to generate contours representing the form of the surface.

Electron holography is the application of holography techniques to electron waves rather than light waves. Electron holography was invented by Dennis Gabor to improve the resolution and avoid the aberrations of the transmission electron microscope. Today it is commonly used to study electric and magnetic fields in thin films, as magnetic and electric fields can shift the phase of the interfering wave passing through the sample. The principle of electron holography can also be applied to interference lithography.

Acoustic holography is a method used to estimate the sound field near a source by measuring acoustic parameters away from the source via an array of pressure and/or particle velocity transducers. Measuring techniques included within acoustic holography are becoming increasingly popular in various fields, most notably those of transportation, vehicle and aircraft design, and NVH. The general idea of acoustic holography has led to different versions such as near-field acoustic holography (NAH) and statistically optimal near-field acoustic holography (SONAH). For audio rendition, the wave field synthesis is the most related procedure.

Atomic holography has evolved out of the development of the basic elements of atom optics. With the Fresnel diffraction lens and atomic mirrors atomic holography follows a natural step in the development of the physics (and applications) of atomic beams. Recent developments including atomic mirrors and especially ridged mirrors have provided the tools necessary for the creation of atomic holograms, although such holograms have not yet been commercialized.

Check your understanding

1. Choose the right answer from the options given below:

   Laser cooling
   a) will cool water
   b) Will cool oil
   c) will cool nucleus
   d) will cool atom

2. State if the following statement is true or false?
   Hologram is a three dimensional image.
   a) True
   b) False

3. Fill in the blank with the right answer.
   1. Laser welding _____, _____, _____.
   2. Laser cutting _____, _____ , _____.

Check the correct answers on page 6.

Summary

On completion of this chapter you have learned that:

- Applications of Lasers in cutting and welding
- Applications of Lasers Laser in heat treatment
- Applications of Lasers Laser in Medical applications
- Applications of Lasers Holography (construction & reconstruction)

Activity

Identify some holograms around you
Hint: If you want to see a hologram, you don't have to look much farther than your wallet. There are holograms on most driver's licenses, ID cards and credit cards. If you're not old enough to drive or use credit, you can still find holograms around your home. They're part of CD, DVD and software packaging, as well as just about everything sold as "official merchandise."

Suggested Reading

1. R. K. Gaur and S.C. Gupta, 'Engineering Physics' Dhanpat Rai Publications, New Delhi(2003)
2. M.N. Avadhanulu and PG Kshirsagar, 'A Text book of Engineering Physics' , S.Chand and company, Ltd., New Delhi, 2005.
http://science.howstuffworks.com/hologram.htm
http://en.wikipedia.org/wiki/Laser_applications

Answers to CYU.

1. d
2. a
3. 1. is a welding technique
   2. is a technology that uses a laser to cut materials