University of technology
Laser and optoelectronics eng. Dept.

LASER APPLICATION COURSE
4TH YEAR
LEC.7

***Example*-8:**

Estimated the diameter of the focused spot size required to achieve the cutting speed (97 mm/s), for aluminum sheet at thickness (1.3 mm) & power output (2Kw) with thermal constants:

C = 903 ***L_V =10.9x10^6*** ***ρ = 2710*** ***T_V = 2720***

Solution:

$$H = \frac{P}{A} = \frac{P}{\pi r^2} \Rightarrow V_P = \frac{P}{\pi r^2 \rho (CT_V + L_V)} \quad \text{.....(1)}$$

$$V_C = \frac{dV_P}{Z} \Rightarrow V_P = \frac{ZV_C}{d} \;\&\; d = 2r \Rightarrow V_P = \frac{ZV_C}{2r} \quad \text{.....(2)}$$

From 1 & 2 $$\frac{ZV_C}{2r} = \frac{P}{\pi r^2 \rho (CT_V + L_V)}$$

$$\Rightarrow r = \frac{2P}{ZV_C \pi \rho (CT_V + L_V)} = \frac{2 \times 2 \times 10^3}{1.3 \times 10^{-3} \times 97 \times 10^{-3} \times \pi \times 2710 (903 \times 2720 + 10.9 \times 10^6)}$$

r = 0.278 mm ***d = 2r = 2 x 0.278 = 0.57***

- ***Summary***
- 1.Laser cutting & drilling can be performed on[4]:
- a. Metals.
- b. Ceramics
- c. Plastics
- d. Cloths
- e. Glass when it's surface is coated with a radiation absorbing material such as carbon.
- 2. A long focal length lens is used in order to produce:
- a. Narrow Kerfs.
- b. Reduce the tendency for the cut.
- 3. To correct or avoid the (tendency of wide Kerf), a gas-jet assisted laser beam can be used, the gas being:
- a. Either an inert gas, such as helium or argon, and employed when the material is prone to burn or oxidize such (cloths or plastics).
- b. Or a reactive gas such oxygen, used to obtain exothermic reaction with metals to produce a clean cut & rapid rate of cutting or drilling.
- 4. For drilling or cutting:
- a. Ruby laser
- b. Nd-YAG laser
- c. Carbon dioxide laser
- Can be used either in the pulsing mode or in the CW.

Laser Welding

- In the basic welding process two metals (which may be the same or dissimilar), are placed in contact and the region round the contact heated until the material melt and fuse together. The laser welding divided here into two types[4]:
- a. Microwelding
- b. Deep penetration welding
- ***a. Microwelding:*** The ***ability to focus*** a laser beam down to an area only a few microns across and the ease with which it can be ***directed*** and ***controlled*** has naturally ***led to the use of lasers in welding and soldering minute metal contact*** such as are found in electronics circuits.
- ***b. Deep penetration welding:*** With the advent of CO_2 lasers with 1kW & higher CW power output it was discovered that the phenomenon of **keyholing** occurs. In this phenomenon a hole is produced in the material, allowing the beam to penetrate deeply into material. Figure (2.2) illustrates this process when a CW is being used.

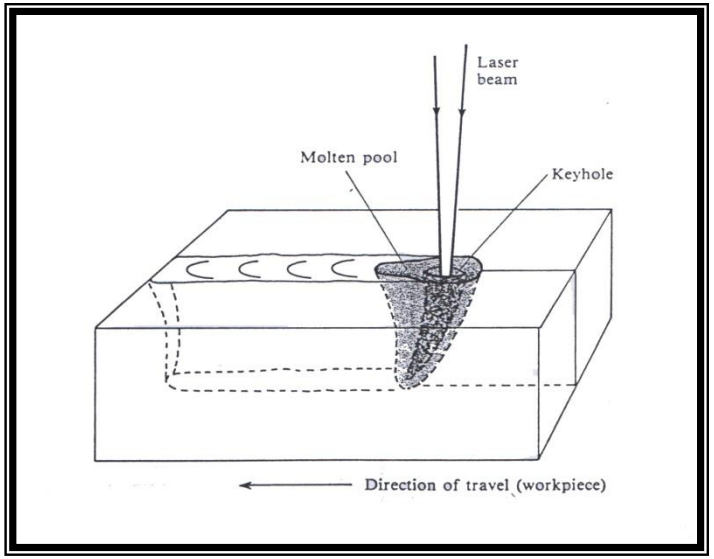

Figure (2.2) formation of a "keyhole" during high power laser welding[4]

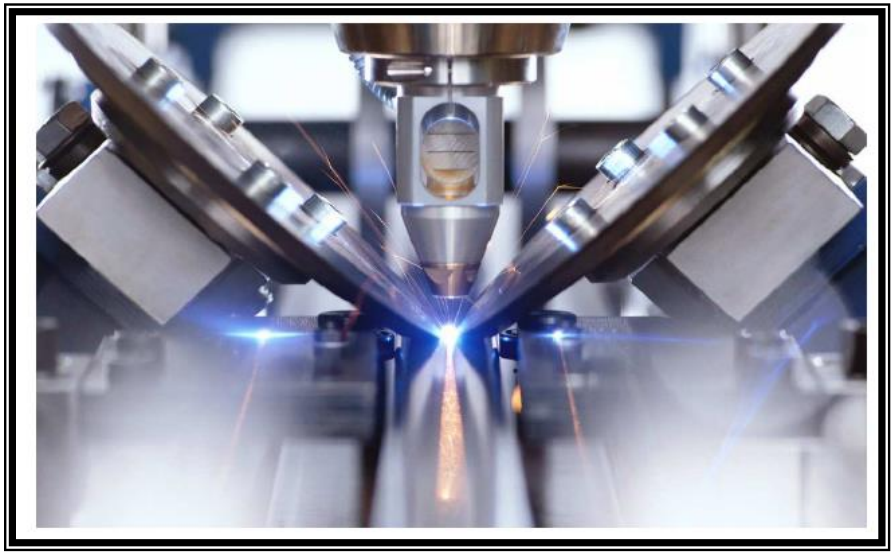

Figure 2.3 Laser Welding

Advantages of Laser Welding

- Among the advantages of laser welding are the following[2,4,6]:
- Minimum heat input, which results in very little distortion.
- Small heat affected zone (HAZ) because of the rapid cooling.
- Narrow, generally cosmetically good weld bead.
- High strength welds.
- Easily automated process that can produce very precisely located welds.
- Weld some metals difficult to weld by other techniques especially dissimilar.
- Weld in areas difficult to reach with some other techniques.