ABOUT THE USE OF LASER CUTTING IN AUTOMOTIVE INDUSTRY

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Abstract: Laser cutting has been around for over 25 years but still manages to maintain a certain mystique. It is still looked on in certain quarters as a special process with limited applications. The authors of this work present general aspects of the laser cutting. The automotive industry is becoming a large user of laser technology, where the laser cutting is used usually for pre-production prototypes or for small scale production, either for low volume variants or for smaller manufacturers of specialist vehicles, kit cars etc. Automotive manufacturers are, however, more and more incorporating multi-axis robotically operated cutting or welding systems into their lines.

Keywords: laser, cutting, automotive industry.

1. THE PRINCIPLE

Laser cutting is an industrial application obtained by the use of a laser device to emit the generated electromagnetic radiation via stimulated emission. The resultant 'light' is emitted through a low-divergence beam. Laser cutting refers to the use of directed high-power laser output to cut a material. The result is a quicker smelting and melting of the material.

2. THE LASER CUTTING PROCESS

To cut metals, some ceramics and plastics, graphite composites, paper and other non-metal cutting applications the Nd:YAG lasers or the CO2 lasers can be used. Cutting requires that the laser beam is focused by a lens to a small focus spot, typically in the 25-100 [μm] diameter range for fine cutting and 100 – 300 [μm] range for thicker section cutting. Coaxial gas is delivered just above laser focus by a nozzle that surrounds the converging laser beam to keep the optics clean and improve the cutting process by pushing the vaporised and liquefied material out through the kerf. Gases such as oxygen and air are used to promote cutting of ferrous alloys and cellulose materials. High-pressure inert gas is used when cutting some metals to leave an un-oxidized edge with little dross. The process of the laser cutting is shown in Fig.1.

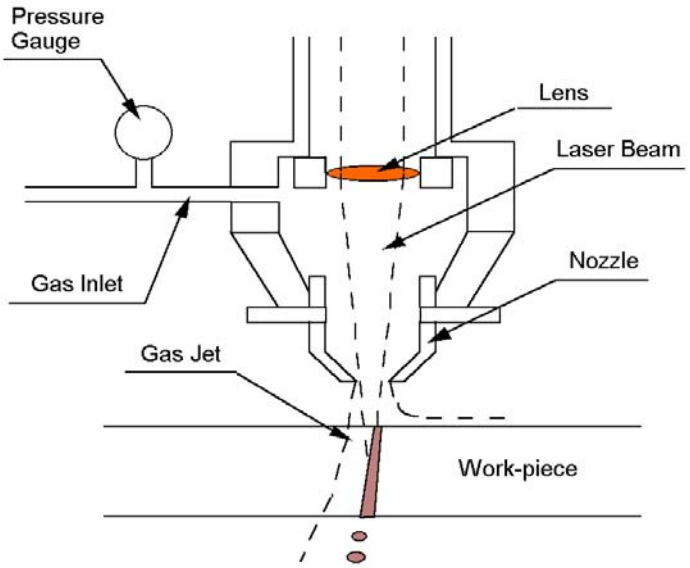

Fig.1. The process of the laser cutting [2].

To cut with laser a few specific methods are used:

- ***Sublimation*** - cutting by means of this method uses the spontaneous evaporating of material due to focused laser beam which is very intensive and/ or is blown out by means of large steam and cutting gas pressure (immediately from solid state to gas state).
- ***Melting*** - this method uses material melting in whole laser beam track and, as consequence, blowing out of material from the gap by means of cutting gas. The main gases used for this cutting operation are argon and nitrogen. Unlike laser cutting by means of burning out the melting method requires the energy for warming and melting of material in cutting gap to be delivered by means of laser beam or it should be delivered by electric current. While cutting in melting method the cutting gas does not take part in exothermic reaction and therefore it does not support the cutting process. That is why the laser with the same power can not cut with the same speed as in next method.
- ***Burning out*** - during laser cutting by means of burning out (oxidation) the material that is being cut is wormed by laser beam, focused on surface in cutting gap region right to the burning temperature. The cutting by burning out is the most often used method for non-alloyed and low-alloyed steels. The material is burnt out in cutting gap due to presence of oxygen and it forms liquid slag which is blown out from the gap by kinetic energy of cutting stream. The exothermic reaction of cutting oxygen with material produces the part of needed energy and let the laser to obtain the big cutting speeds with relatively low laser power. The most often used is a combination of mentioned above three methods for material splitting.

3. APPLICATIONS

Laser cutting has many applications in the automotive industry such as: laser cutting of airbags, laser cutting on composite material, cutting on painted carriages (fig.2).This industry, which demands efficient processing of hydroformed parts, can use these hybrid systems for several applications. With a 3-D cutting head, a modern six-axis CNC with fast processors, and increased speed of the laser along the Z axis, a flat-sheet laser cutter also can cut the trim off 3D hydroformed parts.

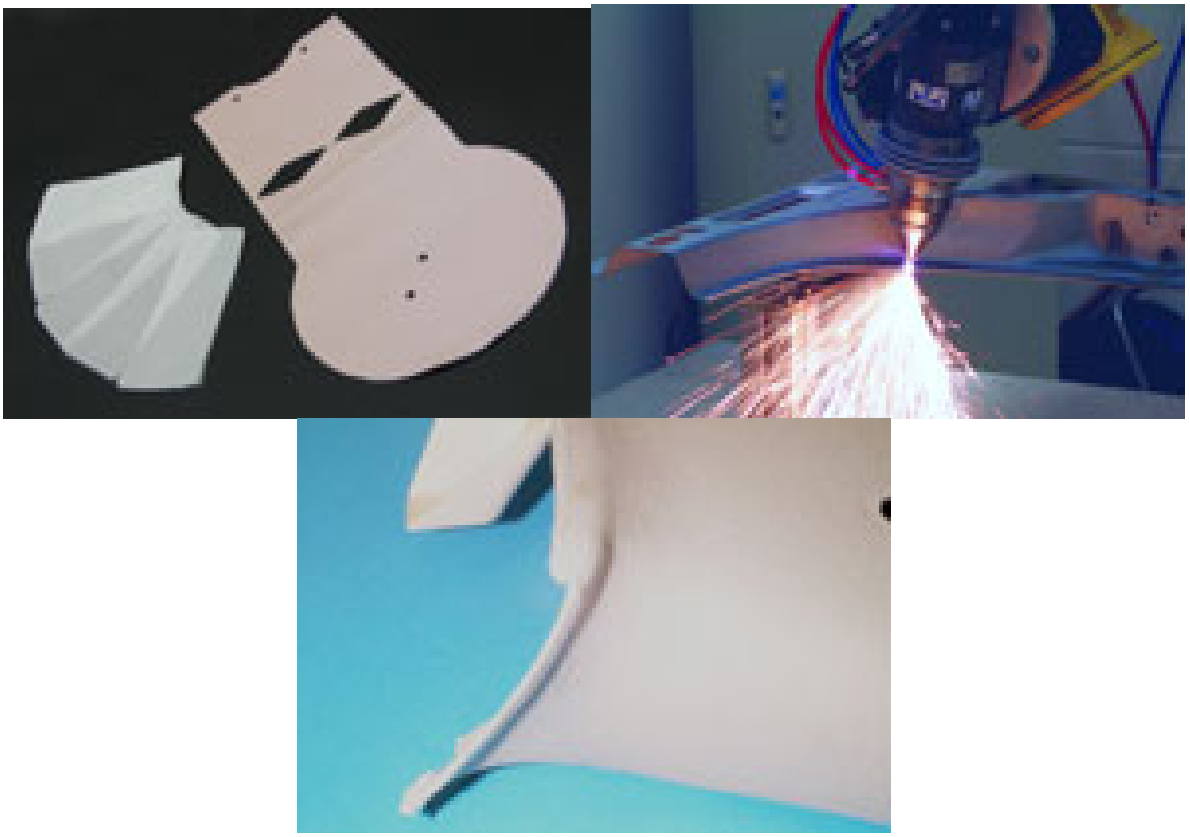

Fig.2. The applications of the laser cutting [2].

Laser cutting of components of automotive type gaskets or engine components is quite practical in automotive industry (fig.3). These products are manufactured using high grade of raw material like sheet metal, mild steel, stainless steel and aluminum.

Fig.3. Engine components processed by laser cutting [2].

3. ADVANTAGES AND DISADVANTAGES OF LASER CUTTING

Advantages

- ✓ Due to rapid rate of operation, the (heat) distortion to the base metal is minimum.
- ✓ The narrowness and accuracy of the cut together with relatively shallow HAZ with negligible surface cracking are major advantages of this process.
- ✓ Even most complicated profiles can be cut.
- ✓ Very hard material like silicon carbide, friable material like glass, sticky material like confectionery etc., can be cut by laser.
- ✓ Laser is a faster process than sawing or nibbling and is very efficient.

Disadvantages

- ➢ Very large resonator cavity required per cutting head, therefore, not normally used in multiple-head configuration;
- ➢ High capital equipment cost;
- ➢ Requires isolation of cutting head for safety;
- ➢ Mirror alignment critical and power level reduces as mirrors degrade;
- ➢ Double material thickness is equal to one-half the cutting speed;
- ➢ Generally not used for steel above 20 mm.

4. CONCLUSIONS

Automotive manufacturers utilize the advantages of laser cutting: the high quality of cutting edges, the time saving (and therefore cost), the need for hard tooling is eliminated, the low heat input into the material as well as the high processing speeds when working with a variety of work pieces around the car. Thereby, a variety of materials is processed: besides a multitude of metals, also materials such as airbag cloth and composites for interior room parts are cut with the laser. Owing to the good possibility of automation, various cutting edges and work pieces with a complex geometry can also be easily generated.

REFERENCES

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