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REVIEW OF LASER PLASTIC WELDING PROCESS

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ABSTRACT

There are many applications were polymer-metal joint is required but commonly they are join by either mechanically or adhesives are apply between them. In adhesive joint surface treatment is required and due to mechanical joint the weight of assembly increase and stress concentration also more at the joint. But now a day's laser plastic welding processes is widely used for polymer-metal joint. Because this process is fast and clean. This welding process consists of two parts. In which one part is transparent polymer and other is absorbing metal. They are clamped between clamp plate and base plate with certain pressure. When laser beam incident on absorbing metal, metal radiate heat due to that polymer at interface fused and join with metal or polymer

Keywords: Absorbing Metal, Clean, Laser, Polymer, Pressure.

I. INTRODUCTION

The laser producing device founded in between 2000-01 by employees of the Bavarian Laserzentrum gGmbH and it is a start of development of laser plastic welding process and after few years laser plastic welding process becomes the important part of quality production. Then Laser plastic welding is widely used in a automobile, medical and other fields

II. LASER PLASTIC WELDING

Laser plastic welding is a process in which either two or more thermoplastic polymer or polymer-metal joined together. There are many processes for joining thermoplastic polymers but laser plastic welding has advantages over them that are follows:- higher joint strength, it not produces flash or particulates, better process controls, less stress to the joining component and it can weld complex and intricate shapes. The process highly depend on passing laser energy through an upper transmissive polymer and the energy absorbed by the absorbing lower layer and lower layer radiate heat which melts the plastics and bubble drives molten polymer then after cooling it creates a weld seam. There are four important factors which is required for laser plastic welding process as follows:-

2.1 Laser Transparent Layer

Most thermoplastic polymers are optically transparent in their natural state but all of them are not laser transparent and for laser plastic welding laser transparent polymer required. Since human eye not observe the laser welding radiation so, in most of the laser welding applications today preferred a laser transparent top layer which is opaque to the human eye. The upper joining partner must be transparent for laser beam whose wave

length in the range of 800nm – 1000nm so the lower joining part absorb this wavelength. For plastic welding only some percentage of the laser energy needs to transmit through the top layer and the rest of the energy will be absorbed, reflected, and scattered from the interface. A minimum transmission rate of laser is 6% required. This rate measured by the LPKF TMG device, companies other than LPKF TMG use different measuring methods and they have different transmission rate guidelines.

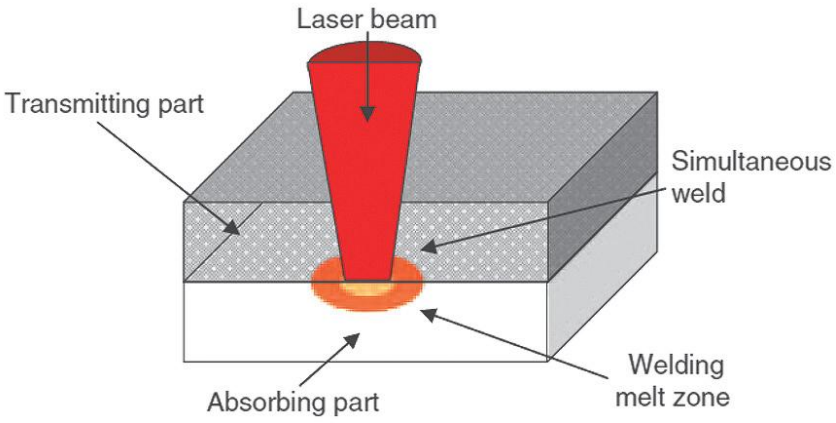

Figure-1:-Laser plastic welding process

2.2 Laser Absorbing Bottom Layer

The laser absorbent layer absorbs laser which is transmitted through the top layer and it is responsible for heating the absorbing layer and if material is not absorbing type then carbon black is used as additive. Usually the amount of carbon black is 0.3 to 0.5% by volume. Ideally, the transmission rate of the absorbing layer should read absolute zero. So all the energy would stay at the surface of the absorptive layer where it is required to radiate heat to the top layer at the interface and due to that it is possible to weld two pieces of plastic to one another. There are two types of method for this. First one is specialized additive, called laser absorbent and the second one does not require any coatings or additives, instead of that special laser wavelengths are used to achieve absorption. This process may not suitable for every application, but it minimizes additives. For plastic coloring, the company BASF developed additive called Lumogen which is commonly used to make laser absorbent resin in a variety of colors. Mostly white color is created by using titanium oxide (TO2) additives and TO2 reflects infrared laser and plastics colored with TO2 not able to absorb adequately. However, the plastic company Orient has developed a special additive that creates white coloring without the use of titanium oxide, see Table for details.

2.3 Material Compatibility

The two polymers, which are to be joined must be of the same type of plastic and having similar remelting temperatures to be joined successfully and for sufficient strength is obtained; otherwise one part may melt or burn and the other will be unaffected. It is safe to note that it is possible to weld the most common thermoplastics, such as: POM, PA6, PA66, PP and PE in their pure form. Table 1.

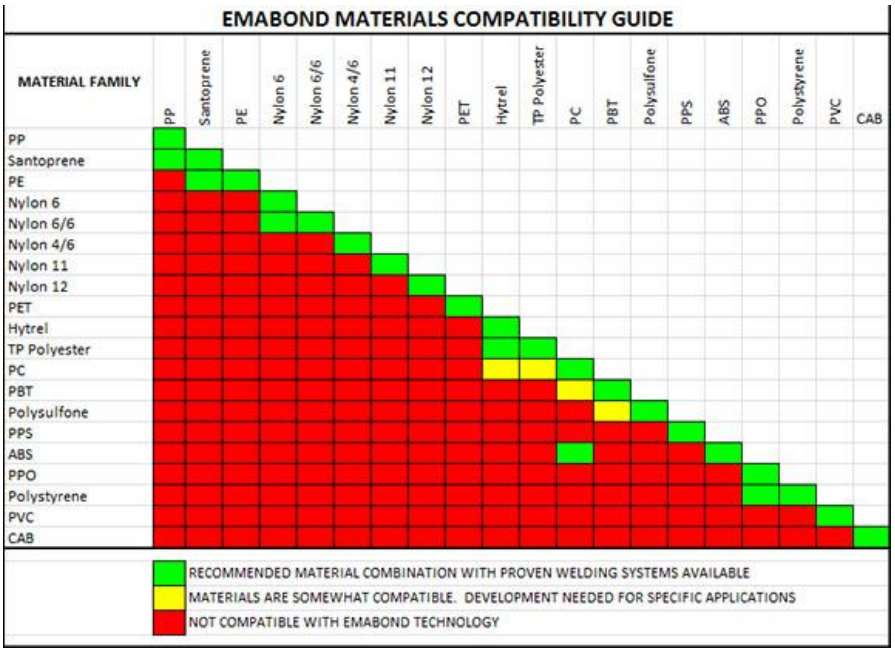

Table 1: Compatibility of Plastics

2.4 Contact

During welding process the lower layer get heated and it transferred to the upper layer so that it melt and flow over as well and conduction of the two layers need to be in contact during the welding with certain pressure ,which ensure proper heat conduction during welding. Contact is done by various methods of clamping devices or special component designs. The Clamping Overview section will cover this in detail. Clamping will help minimize the gaps caused by improper part design or tolerances, but every effort should be made to have accurate parts prior to welding

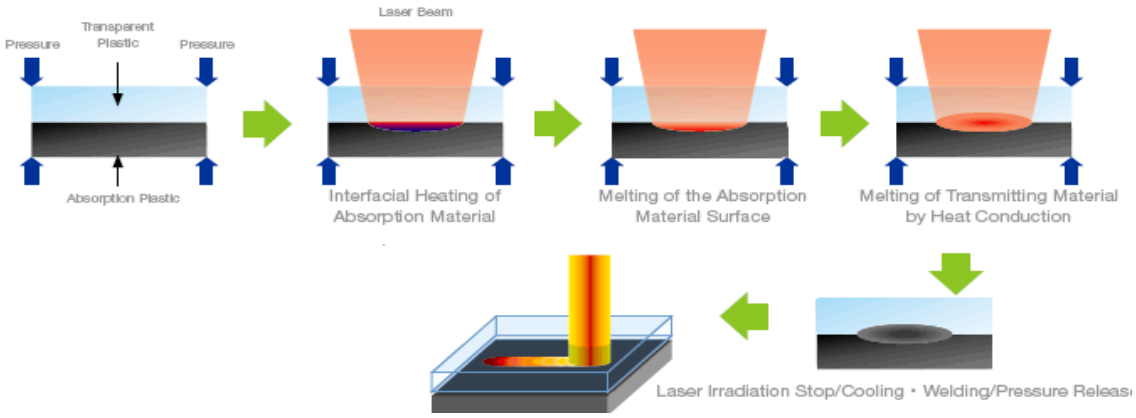

Figure-2:- Welding Stages

III. TYPES OF PLASTIC WELDING

3.1 Contour Welding

In this process the laser beam focused onto a point which moves along the contour line of the joint in single pass. The width of the joint line can vary from a few millimeters to several millimeters. It is especially suited for large parts or three dimensional parts and radial welding.

Advantages: 1.Very flexible

2. Excellent process

3. Quality monitoring

Limitations: 1.Slower cycle times compared to other laser process method

3.2 Simultaneous Welding

Simultaneous welding in which the entire welding region is heated at the same time. By using specially designed fiber-optics, the laser energy is formed into the pattern of the weld seam and it incident on the entire seam simultaneously. In this method laser device is stationary and this method is ideal for high volume runs that require ultra-low cycle times.

Advantage: 1. Fast cycle times.

Limitation: 1. costly as multiple laser sources are typically required small working area (50mm x 50mm)

2. Less precise process monitoring.

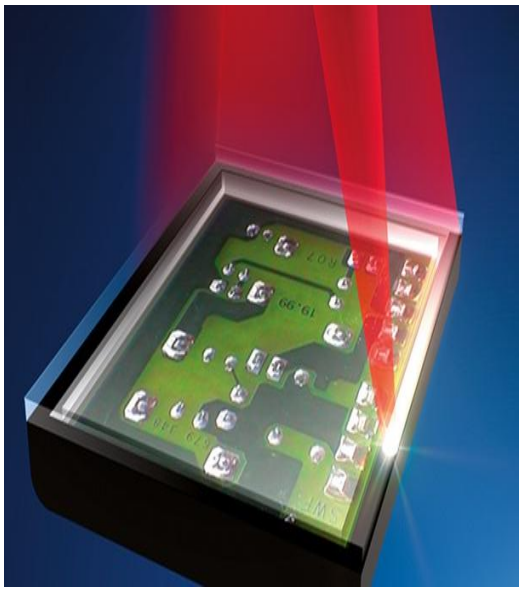

Figure-3:- Contour Welding

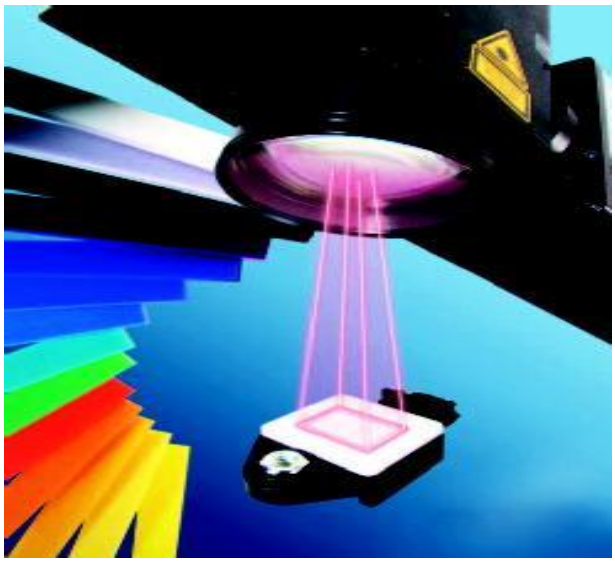

Figure-3:- Simultaneous Welding

3.3 Quasi-Simultaneous Welding

Quasi-simultaneous welding is a combination of contour and simultaneous welding. It has single, focused laser beam. Which is guided by a mirror and tracing the path repeatedly with high speed. In this way the entire joint line is effectively heated equally and simultaneously.

Advantages: 1**.** Fast cycle times

2. Excellent process monitoring, flexible.

Limitations: 1. For mainly two dimensional parts.

3.3 Hybrid welding

Hybrid welding uses high-powered halogen lamp energy to pre heat the joint before the start of normal laser plastic welding process. The halogen lamps pre-heat the plastic around the interface, this effect requiring less

laser energy to melt the plastic. The advantages of pre-heating are faster cycle times as well as reduced part stress from temperature shock.

Advantages: 1. Excellent process monitoring, increased cycle times
2. Uses less laser energy,
3. Improved gap bridging
4. Increased seam strength.

Limitations: 1. halogen lamp projects an 8mm zone around joint seam

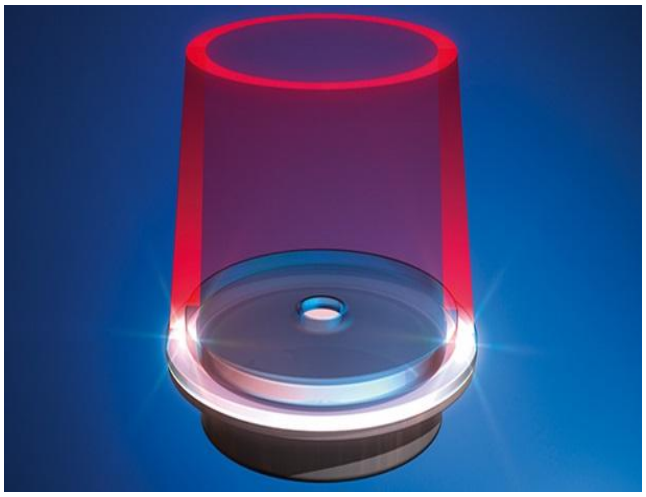

Figure-4:- Quasi-Simultaneous Welding

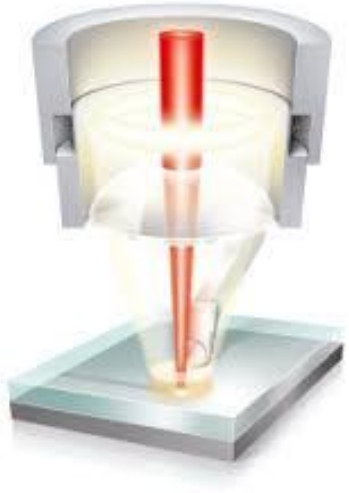

Figure-5:- Hybrid welding

IV. CONCLUSION

The laser plastic joint is better option to other joining process like mechanical or adhesive and this type of joint clean and no liquid or fumes to affect surface finish. This process is effectively used in automobile industries. As the laser applies the melting energy tightly localized, very compact structures with welding seams extremely close to heat-sensitive components can be realized.

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