Laser Plastic Welding

Design Guidelines “Light”

Introduction

The purpose of this document is to provide designers and engineers, in the concept phase of new products, with a brief understanding of laser plastic welding. If you would like more information please inquire about our full Design Guidelines document.

Basic Laser Welding Process

Laser plastic welding is a method of bonding two or more thermoplastic components together. Although there are many methods for joining thermoplastics, laser plastic welding has a few clear advantages: higher joining quality, minimal resulting flash or particulates, higher quality controls, less stress to the component and the ability weld complex and intricate shapes.

The process relies on passing laser energy through an upper transmissive layer down to the surface of the lower layer where the energy is absorbed. The resulting heat melts the plastics and creates a weld seam.

There are four important requirements for the laser welding process to occur. These four points will be addressed in detail in the following section.

The Big Four

1. Laser Transparent Top Layer
Most thermoplastic resins are laser transparent in their natural state. Laser radiation falls under the infrared spectrum; meaning, although, the plastic is transparent to the infrared laser it can be opaque to the visible spectrum seen by the human eye. Most thermoplastics are opaque in their natural state, but are yet transparent to the laser.

There are several influences on the amount of energy transmitted to the interface, including but not limited to: additives, fillers and material thickness.

2. Laser Absorbing Bottom Layer
The laser absorbent layer is responsible for turning the remaining laser energy, once passed through the transmissive layer, into heat at the interface of the two layers.

A commonly used additive to make plastic absorbent for IR laser light is carbon black (typically 0.2-0.4% by volume) since it is very economical. However, there is also a variety of other additives, including colorings, that are IR absorbent.
Note, it is possible to weld two pieces of clear plastic to one another, either using a special additive, (Clearweld™ by the Gentex® company) or by using special laser wavelengths.

3. Material compatibility
The two polymers, which are to be joined, must be of the same plastic family with similar resin properties and melting temperatures; otherwise one part may melt or burn while the other will be unaffected.

The following materials are known to have been successfully welded: PA 6, PA 66, POM, PBT, PC, ABS, PP and PE in their pure form. For a more detailed listing of compatible plastics please request a “Materials Compatibility Chart” from an LPKF representative.

4. Contact
It is paramount that heat energy, generated on the surface of the lower layer, be transferred to the upper layer so that it may become molten as well. In order for conduction to occur the two layers need to be in contact during the welding process.

Contact and pressure are typically accomplished with various methods of clamping devices, see letter “I” from Figure 1 below.

Design Considerations
The follow requirements need to be addressed in your part design for a successful laser plastic weld.

Melt-Collapse
Melt-collapse (E, Figure 1) is the distance the joining partners travel as they move together under clamping pressure. This collapse allows for material fusion and a bond to occur. If joining two flat pieces, a raised rib (F, Figure 1) will be required to allow for melt-collapse to take place.

Figure 1 – Pre-Collapse
Figure 2 – Post-Collapse

Beam Accessibility
Parts need to be designed to allow direct access for the laser beam to the weld joint, shown as “A” in figure 1. Accessibility should take into consideration joint width plus part and positional tolerances.

Note, the laser beam may enter the joint at angle of 90° +/- 15°.

Joint Design Legend
- Translucent Layer
- Absorptive Layer
- Beam accessibility
- Clamp tool spacing
- Top layer depth
- Melt cover width
- Melt collapse
- Raised rib
- Mechanical limiting stops
- Melt cover
- Clamp tooling
- Weld flash
- Flash/melt blow-out zone
Clamping

The part should have allowances for clamp tooling (l, Figure 1) along the entire joint from above, as well as support from below in the form of a workpiece holder or nest.

Figure 1, above, represents a joint prior to collapse, where figure 2 shows the same joint after melt-collapse has taken place. Notice the weld flash (J) from the compressed rib.

Consultation and Contact Information

This document is intended as a brief introduction to laser plastic welding. For a more in-depth look please request a copy of our full Design Guidelines document using contact information below.

Please understand these are only guidelines and your application may vary from them. We recommend you consult an LPKF specialist during your design process.

Please, contact us for design/feasibility advice or for sample runs. Inquiries can be sent to:

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New resource -> www.laserplasticwelding.com

Here are a few details we recommend having available when you contact us:

- A basic summary of your application
- Device diagram, computer model or specifications
- Material Information
  - Types of plastic
  - Number of layers
  - Thickness
- Desired cycle time
- Seal requirements
- Other requirements:
  - Strength/load force
  - Optical
  - Function
  - Tolerances
  - Other
- What is your reason for considering laser plastic welding?

Full Design Guidelines Document

For more information, please request a copy of our full Design Guidelines document using the contact information to the left or follow the link below to view it from your web browser:

http://www.lpfusa.com/lq/lq_dgl_download.html