Laser Processing

The laser beam is the heat source in laser materials processing. Even though the laser is normally considered to be a light source, it is also a form of energy and as such can be a useful source of intense heat when concentrated by focusing. Lasers are able to produce high energy concentrations because of their monochromatic, coherent, and low divergence properties compared to an ordinary light source. As a result, they can be used to heat, melt, and vaporize most materials. The processes for which lasers are commonly used include welding, cutting, surface modification (including heat treatment), and forming.

GENERAL ADVANTAGES AND DISADVANTAGES OF LASER PROCESSING

Lasers have several advantages over conventional techniques that are normally used in materials processing. At the same time, there are disadvantages that may make lasers less suitable for certain applications. These are outlined in the following paragraphs and further elaborated on with respect to specific processes as they are discussed in subsequent chapters.

Advantages

1. The ability to focus the beam to a small size, thereby attaining a high intensity and highly localized heating source with minimal effect on surrounding areas. Spot sizes may vary approximately from 0.001 to 10 mm.

2. The ease with which the beam power can be controlled by regulating the current through the electric discharge.

3. Minimal contamination of the process.

4. Ability to manipulate the beam into ordinarily inaccessible areas using mirrors and fiberoptic cables. 5. Minimal heat-affected zone and distortion.

6. Noncontact nature of the process.

Disadvantages

1. Relatively high capital cost of equipment.

2. High reflectivity of laser beam on metals.

3. Low efficiency of lasers.

4. Energy waste by beam dumping when the laser is not used continuously.

Annealing:

Annealing is widely used to improve the characteristics of materials, in particular thin films, with applications extending from wafer scale to large substrates. Laser annealing can activate dopants for advanced CMOS circuitry, sensors, IGBT, 3-D integration and more. Excimer lasers are widely adopted for the crystallization of amorphous silicon films used to form the polysilicon layers that provide the electrical functionality for high resolution displays. Laser crystallized polysilicon also provides the stability required to drive OLED displays. Depending on the materials and layer structure of the thin films, different laser wavelengths, pulse widths and power levels are used. The VYPER excimer laser is our "workhorse" to anneal 100 nm a-Si film on large glass substrates that enables production of high resolution displays. UVblade systems are also used for fast and gentle separation of flexible displays resting on polymer films from their rigid glass carriers. Its large format processing beam is capable of releasing hundreds of flexible displays every minutes.

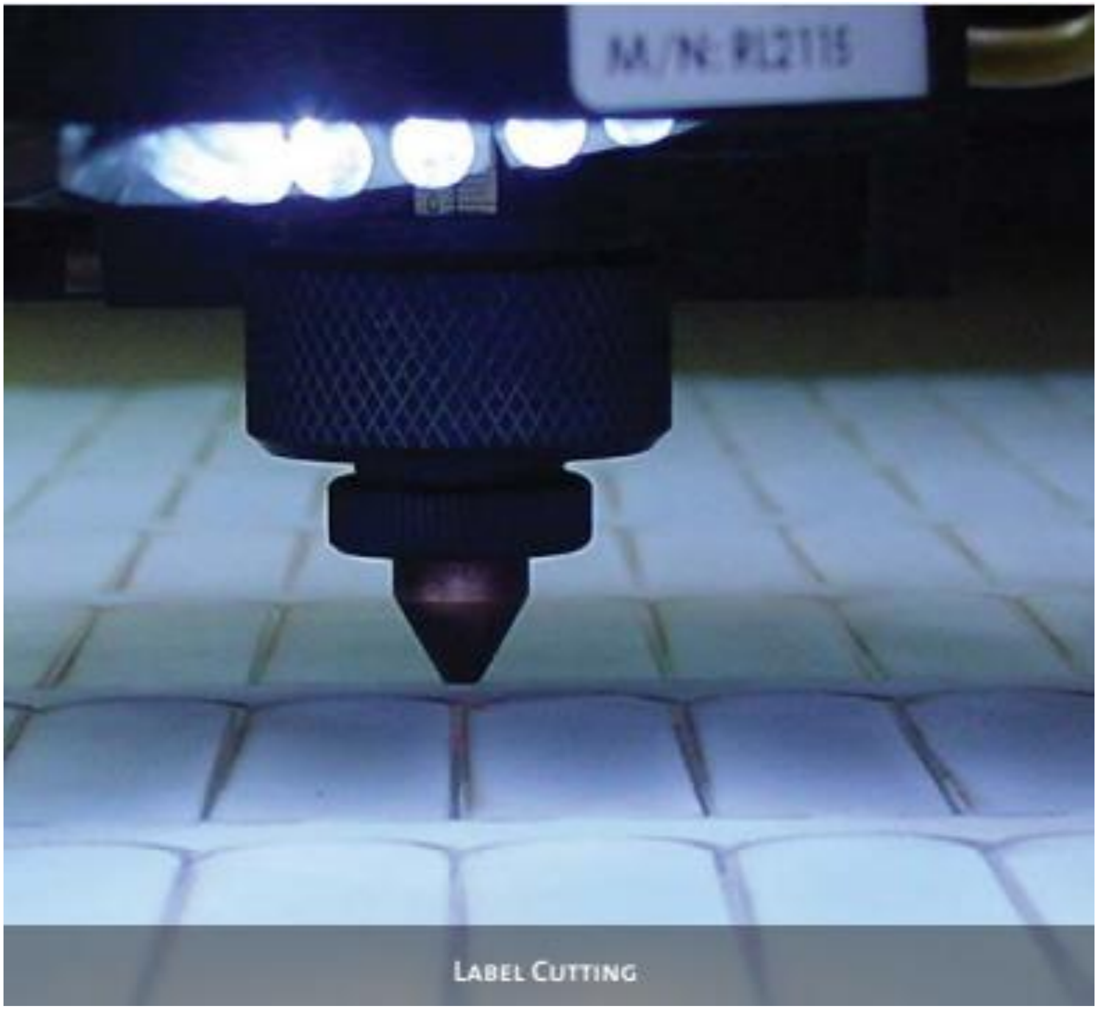
Welding:

The main benefit resulting from using a laser for this technique is high processing speeds with no tool wear due to a contact free process. The process leaves low heat affected zones and low part distortion resulting in small welding seams with very little need for post processing. A high degree of automation display manufacturing including process monitoring, control, and documentation enable excellent product quality and repeatability. Typically any metal that can be welded by conventional technology can be welded by a laser. For keyhole welding, materials with a higher thickness-towidth aspect ratio are welded with 1 μm wavelength from a HighLight FL-Series fiber laser. Sheet metal up to 2 mm can be heat conduction welded using a HighLight D-Series direct-diode laser. In addition, a selection of plastics can be successfully welded using a transmission welding process. The ideal laser for this process is the HighLight FAP System. Glass welding is a growing application in the display manufacturing to provide the perfect hermetic sealing of AMOLED displays. Our HighLight FAP systems are widely adopted in industry for this frit welding process.

Cutting:

Laser cutting is a mature industrial process with high flexibility, noncontact and stress free processes that produce finished parts direct from the tool. Laser cutting is a very precise process, with excellent dimensional stability, very small heat affected zone, and narrow cut kerfs. Various technologies are used in this process depending on the type of material to be cut. Plastics, ceramics, fiber-reinforced materials, and organics such as leather, fabric, paper, wood and others are processed ideally with Diamond CO2 lasers. Its wavelength of 10.6 µm offers optimal absorption to cut by evaporation or melting

non-metal materials. While the 10.6 µm wavelength from Diamond CO2 lasers offers the ability to cut plastics and metal materials, HighLight FL-Series fiber lasers emitting 1 µm wavelength are the optimal tool for cutting metals including high reflective materials like Aluminum, Copper, Brass or Stainless Steel. Other brittle and transparent materials open the opportunity for ultra-short pulse and UV lasers. For example the cutting of glass and sapphire with inner/outer contours and bevel is very effective using our high power ps-laser products.



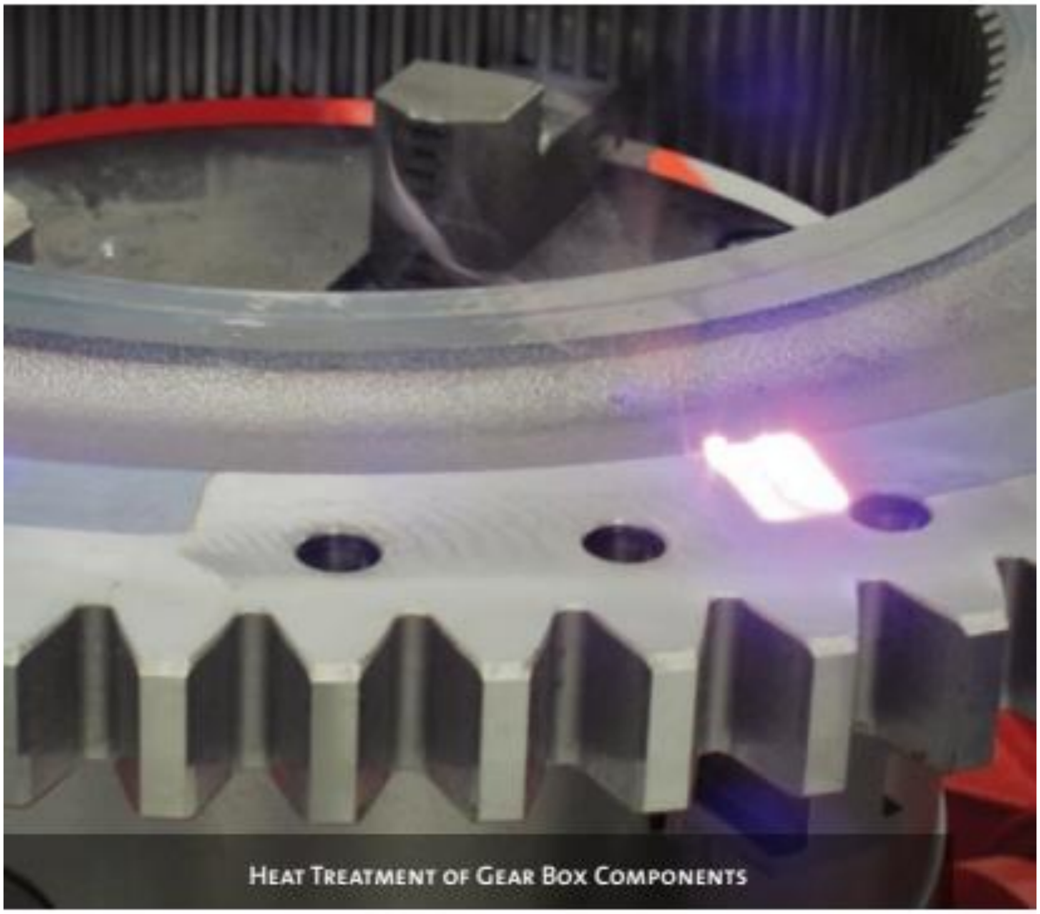
Marking and Engraving:

Lasers are commonly used for marking and engraving of materials. There are a wide range of applications found in the automotive, electronics/semiconductor, aerospace, medical, consumer products, gift & trophy, and food/beverage industries. It is a very flexible, basically maintenance- free process, and the results are very precise, creating sustainable marks on a large variety of materials. It is also low in consumable cost. When marking metal surfaces, the high peak power of a 1 µm laser, such as a MATRIX DPSS laser, engraves into the metal surface and creates the desired contrast. When marking plastics, the exact color of the mark is highly dependent on the additives found in the plastic. If a high quality mark with high contrast or color change is required, a 1 µm, 532 nm or 355 nm wavelength from the MATRIX Series is used. A CO_2 laser like the Diamond C-Series, emitting a 10.6 µm wavelength can, in most cases, engrave without color changes based on the melting of the material. Typically a CO_2 laser with 10.6 µm is used for marking organic materials like wood, paper, cork, leather and horn and

creates a dark contrast. The CO_2 laser also removes paint or discolors fabric effectively. Glass marking is supported by our DPSS lasers as well as excimer lasers depending on the characteristics of mark being inside the glass or laser etched onto the surface.

Heat Treating:

In laser heat treating or case hardening, a spatially well defined beam from a High Power Direct-Diode Laser is used to illuminate a work piece. The light causes rapid heating that is highly localized to the illuminated area and does not penetrate very deep into the bulk material. The bulk heat capacity of the material typically acts as a heat sink for the extraction of heat from the surface therefore enabling self-quenching. Coherent direct-diode HighLight D-Series and fiber laser HighLight FL-Series lasers enable rapid processing, precise localized control over case depth/hardness, minimal to no part distortion, superior wear and corrosion resistance, and increased fatigue strength. Part geometry and carbon content (min. 0.3%) significantly influence the results that can be achieved with a laser heat treat process.



Heat Treatment of Gear Box Components