1 Why Apply Laser Welding for Thermoplastics?

Plastic has become widely accepted as a standard material for everyday consumer goods. If one closely scrutinises a car today for example, it will become obvious that many parts which had been made from metal in the past have meanwhile been replaced by plastic parts. One will come across a number of plastic housings in the engine compartment and even some car body panels are already manufactured from plastic. But why is it that the application of plastic is so appealing?

First of all, the weight is an important factor: the lightweight plastic housings in the engine compartment are stable enough to protect the electronic assemblies inside. Why apply heavy metal housings instead? Furthermore, most plastic housings provide good insulation against electricity, they are corrosion resistant and they can be very flexibly moulded in the production process. Thus, it is possible today to produce even complex geometries from plastics by means of accurate plastic shaping. Everyone who has already drunk hot coffee from a plastic cup once has faced a further phenomenon in connection with plastic materials: they are bad heat conductors. When drinking coffee this prevents you from burning your fingers and in the engine compartment it protects the electronic assemblies inside the plastic housings against the heat from the

engine. With all these examples one has to take the price into account of course. Applying plastic materials, especially in a large-scale production, is a low-priced solution.

The growing number of plastic parts brings about the necessity to join components which have been manufactured from this material. Many applications – such as cables and switches or coverings and housings of any kind, for instance – call for the connection of plastic components. For these purposes different methods have asserted themselves in the course of time. A classic joining technique is the bonding of plastic components for instance. The disadvantage of this technique is the additional work for applying the adhesive before the actual joining process. Therefore it is preferable to find alternative methods, which allow the fast joining of plastic components without the application of additive materials. Today, one uses a technology which is already known from metal processing: welding. This method can be applied for a number of plastic materials (thermoplastics p. 15) because, like metals, they melt at high temperatures and can thus be joined when pressure is applied.

Different methods for heating plastics have been developed over the years. The most common techniques are heating by means of a heated tool (heated tool welding), the generation of heat by means of friction (vibration welding) or heating with the aid of sound energy (ultrasonic welding) [1]. None of these technolo-

gies can be universally applied; each has its advantages but also process-related disadvantages.

A comparatively new approach for heating plastics is the application of laser technology. The heat which is necessary for melting plastics is delivered directly to the joining spot with the aid of a high-energy laser beam. This brings about a number of advantages:

- The laser beam is a non-contact tool and therefore operates wear-free. The material surface is not damaged. **non-contact processing**
- The laser operates without force. Thin-walled and filigree components, e. g. foils or membranes, can be welded accurately [2]. **force-free processing**
- The disposal of energy is locally restricted, i. e. the laser energy is only inserted in the welding zone. Thus, it is even possible to place the weld seams close to damageable and temperature sensitive components such as electronic circuits. **local energy disposal**
- Air- and watertight weld seams can be produced in such a way that the seams are invisible. The result is a high-quality aesthetic impression. **hermetic weld seams**
- Laser welding does not call for preliminary or subsequent processes. Activation and drying time is not required as opposed to bonding. **no pre- or postprocessing is necessary**

clean surfaces

- The surface remains clean; micro-particles, bonding residues or surface roughness can be avoided.

3D weld seams are possible

- The laser beam delivery is flexible and freely programmable. Thus, it is possible to weld complex three-dimensional components.

elaborate clamping technique

There are, of course, also some disadvantages of laser welding of thermoplastics in contrast to other welding techniques. An elaborate clamping technique is required for example when welding complex components. In many areas the advantages of laser welding of thermoplastics are not yet known however, which is often a hindrance for the application of this technology. It is therefore the intention of this handbook to illustrate the potentials and limitations of this technology.