The use of plastics in medical engineering is increasing constantly. Apart from medical disposables, the application of plastics has also become relevant with regard to complex systems. A further development of existing products not only aims at saving costs, but also at the products to become safer and more comfortable for the patient. This has become a trend with low-cost ambulant therapeutic devices which are required to assure the patient’s security and agility at minimised treatment expenses. An infusion pump by the medical technology specialist Rowe-Med, which is being welded by use of laser radiation, complies with these criteria.

The Rowe-Pump is a physically powered, patent pending infusion pump, developed and manufactured by the medical technology specialist Rowe-Med in Parchim. It is used for critical drug administration and is the first injection pump worldwide featuring a device to control constancy of flow rate without use of additional electrical equipment. It combines performance, safety, comfort and patient flexibility and may be used for both intravenous and subcutaneous injection. The application area of the pump is wide, ranging from oncology, pain treatment and administration of antibiotics, corticoids, hormones, anticonvulsants and spasmyotics into the field of cardiology. The robust pump is available in different filling volumes. Depending on the application area, it can be used with different flow rates, ranging from 0.5ml/h to 25ml/h. The deviation of the constancy of flow rate does not exceed ± 5% during the time span of injection. Another positive aspect is the comparatively small rest volume of drugs remaining, accounting for less than 1 ml. All these advantages for both physician and patient are based on a fully-developed design, the assortment of suitable materials and additives as well as on accurate, well-coordinated manufacturing-processes. In order to achieve the necessary precision, the joining process has to fulfil the special requirements of the components that are critical for the apportioning. Under these conditions, laser transmission welding, featuring contact-free and precise energy-input, is considered a suitable joining process.

Choosing and optimising processes
The requirements regarding the weld-seams of the pump are high. The material in use is a polycarbonate, especially optimised for application in medical technology. The midsection of the housing is dyed blue according to the design specifications. In the midsection, a transparent lid is welded onto each side. The components need to withstand internal pressure of up to 4 bar. The pump is used in direct con-

Two lids are welded precisely and dust-free onto the pump by use of laser transmission welding.
tact with the patient and needs to meet high standards of hygiene. Furthermore, the integrated micro-channels feature diameters in the area of > 10µm. The welding environment therefore needs to be dust-free and protected from contamination. Since the micro-channels are located in immediate proximity to the weld seam, energy input needs to be extremely precise. Last, but not least, cycle time should be as short as possible. During the evaluation process it has soon become evident that laser transmission welding is a suitable procedure meeting the requirements listed above.

Nonetheless, the solution was not found easily. The first of the preliminary tests were deflating: the penetration depth of the particular laser radiation into the blue-dyed material was too high. Neither dimensional accuracy nor firmness could be met as required.

At this point, a close collaboration between the material manufacturer, Treffert Polymer Technology, the manufacturer of the laser systems, Leister Process Technologies, and the medical-technology company set in. The task was to develop a colour corresponding to function: The colour needs to equal the blue of the company colour of RoweMed, meet the high requirements of medical technology standards and allow for optimal absorption of the laser’s energy into the surface of the workpiece - without affecting the mechanical properties of the plastic.

Depending on the type of polymer, plastics are usually to 95% transparent to light in the NIR area. It is only after admixing additives and/or dyes that energy is absorbed and the plastic thus melted. In order to determine the optimal formulation, a development with absorption at 950 nm was started first. As the resulting surface absorption was too little, the manufacturer developed a formulation with a maximum of absorption at 1064 nm. The resulting colour did not meet the requirements of the medical technology company, however. The optimal shade of colour exhibiting the required absorbing qualities was finally achieved at lower wavelength. In order to provide consistent distribution of the absorber within the plastic’s matrix, a compound was produced. The next step was to avoid occurrence of a weld bead between the joining partners since this would affect the welding process negatively. After optimizing tools and die cast processes, sink marks which were causing disruptions larger than 0.1 mm could be eliminated.

The laser system in production line
The different parts of the pump are joined by laser transmission welding using a system of the Novolas WS product line. The system is equipped with a 50 W diode laser of the wavelength required by the absorber. Its two linear axes feature a traverse path of 250 mm each in order to conduct the relative movement between laser beam and workpiece. Considering a lot size of 200 000 to 400 000 pieces a year, a standard workstation featuring a hand work place is most suitable. Charging and discharging of the system is done manually. The actual welding process happens automatically in a laser secured, enclosed section within the workstation. The clamping device is double-featured, allowing for two individual workpieces to be clamped simultaneously. At every cycle, a lid is welded onto the middle section of each workpiece, followed by an under-part, which is then welded onto the assembly. This procedure allows for a finished workpiece to be discharged of at every cycle. Hence, it is thus not necessary to retool the system. The welding of the components is thus completed and no semi-finished products need to be stored.

In order to simplify and to guarantee a secure process for the operator, the system is equipped with following features: The workpiece holders on the clamping device are monitored to detect presence and positioning of the workpieces. The opening for assembly is secured by light grid. This allows the system to recognise, whether the assembly has been completed by the operator. If so, the process is initialised automatically; no additional manual start signal will be necessary.

Due to the resulting cycle time, the system is to 50% busy producing the required lot size. The free capacity could be used to extend production or to weld other workpieces.

The lids are welded onto the pump by use of this laser system Novolas WS.
Another option for the medical technology specialist would be to increase capacity utilisation by doing commission processing for other companies.

Laser transmission welding of thermoplastics is becoming more and more popular for applications in the field of medical technology. It allows the user to profit from advantages like high precision of the weld seam and clean, dust free welding process without having to cut back on other weld qualities such as firmness. Collaboration in early phases of the project between user, manufacturer of master-batch/compound and the manufacturer of the laser system, allows finding economic, high-quality solutions for a broad variety of applications.

The infusion pump RoweOumo by RoweMed AG
(original size: 100 x 60 x 20 mm)

Authors: Dipl.-Ing. Oliver Hinz, Produktmanager Lasersysteme, Leister Process Technologies, Kägiswil/Schweiz oliver.hinz@leister.com

Dipl.-Ing. Nadia Einnolf, Produktmanagerin, RoweMed AG, Parchim/Deutschland nadia.einnolf@rowemed.de

Dr. Sibylle Glaser, Leitung Entwicklung, Treffert GmbH & Co.KG, Bingen/Deutschland sibylle.glaser@treffert.org
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