Laser High Tech on River Maas

MARECO – From overhauling ship motors to 3D laser welding of polymers

1939 – Heavy shipping traffic on river Maas. The river is an important transport route for the European land-locked countries towards the North Sea. This was reason enough for Sjaar Janssen to establish a company for repairing and overhauling ship motors close to the banks in Venlo. Mareco should become a story of success. In 2007 - Luc Janssen, grandson of the company's founder is talking about the benefits of his newly bought ROFIN-3D-laser welding system for polymers. Together with his father Wim Janssen and his brother Marc, he manages the company today. And now, 68 years after the start of the company, it has become quite calm on river Maas. Broken ship motors? Negative!

Taking changes as a challenge

No doubt, it is a long way from overhauling ship motors to laser welding of polymers! But that is exactly the reason why Mareco is the paradigm for medium-sized family-run companies who have taken up the vicissitudes of the market and devise new challenges.

In the late Fifties, they switched to manufacturing molds and dies for the production of vulcanized rubber and bakelite, too. Later, in the Seventies, Mareco entered the injection molding business for the extremely expanding plastics industry. It was not long, that a special department for prototype production was startetd and later they had their own injection molding plant. In 1995, the company was among the first to provide their customers with rapid prototyping using the Selective Laser Sintering technology. And today, they are the first company in Benelux to offer 3D laser welding of polymers.

There is of course a certain logic behind this development: prototype and mold production, moldflow analysis, injection molding and quality assurance - it is Mareco's target to offer complete development and production processes all in one hand. And laser welding is simply the future joining technology for polymer parts featuring decisive advantages towards gluing or ultrasonic welding.

Fig. 1:
Some of Mareco's different injection molding machines

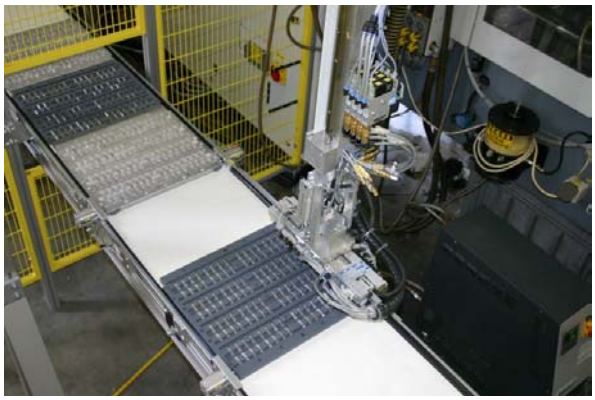

Fig. 2:
Sophisticated robot handling of delicate filter meshes

Mareco's philosophy

'We are specialized in moulding highly qualified polymers like PEEK, LCP, PVDF, PPSU, IXEF or fiber filled composite materials. For this kind of sophisticated polymers we want to offer our customers complete solutions allowing almost any weld contour.' Luc Janssen describes his company's target and reasons which lead to the acquisition of the 3D laser welding system. More than 30 years of experience in injection molding of common polymers (POM, PPS, PC, etc.) are certainly the best basis for this ambitious target. At the beginning of 2005, they commenced to show serious interest in laser welding. Supported by LIOF and an EU-sponsored project, the order was placed at ROFIN already in May. Huge experience in polymer welding was the big benefit which made them decide for ROFIN. ROFIN Laser Micro was among the pioneers who got engaged in this innovative field. With the support of co-operations with producers of polymers and pigments, specialists in the ROFIN application lab have been ready to make sampling and welding tests in a very short time. 'Quick decisions - as soon as profound information is available', that is what managing director of ROFIN-BAASEL Benelux, Pierre Scheyvaerts cherishes most with customers like Mareco. ' Brief decision and planning processes are the excelling strength of the company.' Already in September 2005 test runs were started and a local system integrator installed the StarWeld Diode Y-100, an industrial robot, a working chamber and a large turntable.

Fig. 3: Luc Jansen from Mareco and Pierre Scheyvaerts from ROFIN

Why laser welding

In most cases gluing of polymers requires surface prepossessing using organic solvents. For this reason it does not come into question for certain applications. Apart from that it is very difficult to glue some commonly used unipolar polyfine (PE and PP). Using heating elements or hot air for welding is cost-saving but inert, these tools, however, wear out by direct contact with the polymers. Heating takes place on a large area what is disadvantageous for sensitive components. With friction welding, vibration welding or ultrasonic welding, workpieces are exposed to high mechanical strain and for this very reason, they require complex product design and regular maintenance of the machines. In particular, ultrasonic welding requires specially designed workpiece geometries so that the energy is transmitted to the right places.

Laser welded joints, however, can stand high mechanical load and they are pressure-tight. Samples at Mareco only burst at 5.5 bar test pressure, notabene not at the weld seam, but the parts themselves broke next to the seam! The method allows almost any welding seam contour, and it can be adjusted very flexibly to any workpiece geometry. The surface quality is perfect, there are neither micro particles nor glue residues nor rough surfaces.

The process

Low heat conductivity and flow characteristics of polymers suggest a typical welding geometry where the isotherms of the pool crater sufficiently overlap with the joint area: overlap welding. With overlap welding, the laser beam penetrates the upper partner and is absorbed by the lower. When the latter is heated it comes to plastification which bridges the workpiece gap and heats up the upper partner (via heat conductivity).

Added materials like pigments usually make for the absorption of laser power. Many pigments which are used for coloring, absorb in the IR range and can thus be used for laser welding. If there is at least one dark partner, there are already standard solutions available. For combinations of bright and strong colors, there are laser additives for flexible use available which absorb in the corresponding wavelength range. Welding of bright or transparent polymers - especially required in medical device technology - is done by using laser absorbing high performance additives. White on white combinations require individual solutions due to scattering and low transparency of widely used titan oxide.

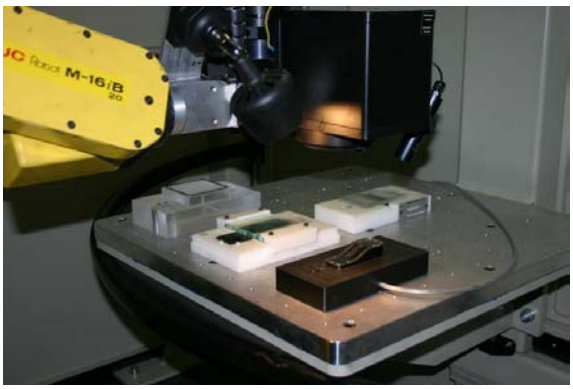

Fig. 4: 3D welding test setup with various workpiece fixtures

Fig. 5: 3D welded sample, highly pressure-tight up to 5.5 bar

3D Laser welding at Mareco

Complex injection molded parts cannot necessarily be welded with the 2D or 21/2D method. Often the welding contour is not plane and hard to access due to notches and undercuts. Mareco counts on the combination of ROFIN's diode-pumped Nd:YAG laser with galvo deflection head with a 6 axis industrial robot. ROFIN's dynamic beam welding technology with galvo deflection heads is technically mature and has been proven in industry for decades. This combination with the industrial robot provides absolute freedom also for processing in the third dimension - and additional software work for the control and coordination of the motion and positioning systems. Additionally, you need know-how of the construction of the components' fixture to secure contact pressure and setting gap adjustment. Mareco have now acquired this know-how. Today, Mareco is in a position to weld most of injection molded parts at a very high quality. Moreover, there is huge know-how of laser friendly construction of parts which is passed onto customers already during the design phase.

Fig. 6: Working chamber with huge turntable

Serial production start

The actual stage of research and testing is already over at Mareco despite the innovative technology. More often, first serial productions use the laser welding system to full capacity. More and more customers from production of high performance print-heads to automotive industry or medical device technology are testing new possibilities of this innovative joining technique. Its flexibility, high strength of the weld, both low thermal and mechanical load of the components which are the decisive factors that count. In this way components may already contain highly sensitive sensors during welding. This opens up new possibilities of car body designs in the automotive industry where metal may be replaced by polymers thus saving weight, among other things.

For injection molding, Mareco have already used industrial robots in the production process, such as for manipulating highly sensitive metal filtermeshes which are selectively overmoulded with the injection molding technique. These components might be subject to damage when processed by human operators. Already today Mareco has the necessary know-

how to integrate injection molding and laser welding processes into an efficient whole process.

What the next 68 years will bring - nobody knows. Janssen sen. and jun., however, are confident to realize also other future developments into orders with such great success as they have done up to now. And the odds are good that laser technology will be the factor of success at least as long as ship motors used to be.

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