DesignSolutions
SOFTWARE, MATERIALS AND COMPONENT SOLUTIONS FOR THE DESIGN ENGINEER

LSR PROCESSING TECHNOLOGY: SHAKING UP LEADING INDUSTRIES

INSIDE

MECHANICAL COMPONENTS
Chain is withstanding the rigours of operation in the automotive industry, where 24/7 operation is demanded

14

THE MEDICAL INDUSTRY
Non-invasive sensors, smart rechargeable batteries and tough connectors are important for wearable IoMT devices

18

MATERIALS IN DESIGN & PROTOTYPING
Textiles are evolving: from 'connected clothing' to fabrics for industrial use

37

LSR PROCESSING TECHNOLOGY: Shaking up leading industries

Trelleborg Sealing Solutions is revolutionising several industries with its pioneering Liquid Silicone Rubber (LSR) and two-component injection technology, which produce innovative solutions for Original Equipment Manufacturers (OEMs) and end users

The need for ground-breaking technology has grown exponentially, particularly in high-tech fields of applications.

The technical possibilities with LSR are endless and can be applied to numerous fields – be it automotive electronics with the thrust of the fully autonomous car, or medical combination products for self-treatment of chronic ailments, or an increasing number of hi-tech lifestyle products for the growing affluent urban society.

Trelleborg has very quickly become a technology leader in the healthcare sector by providing innovative solutions for evolving state-of-the-art medical treatments, such as wearable devices used for digital health monitoring and personalised medication.

The benefit to the device manufacturer is a hygienic, robust and cost-effective product design, often at times combining multiple components and functions into a single one, which eliminates the risk and cost associated with a secondary assembly.

HELPING HEALTHCARE

Ursula Nollenberger, LSR Components product director for Trelleborg Sealing Solutions, said: "We are extremely proud of the LSR technology that we continue to develop and employ with a foundation of specialised LSR toolmaking and process engineering laid in Switzerland which have been in place for more than 30 years.

"The fact our technology is being adopted by major production industries all over the world means our customers have seen the huge benefit of our products. We thrive on finding solutions for our customers which sometimes they never thought would be possible."

Trelleborg works with many facets of the healthcare industry, device designers, contract manufacturers, biopharma companies, and OEMs.

With the increase in personalised medication, devices must become user friendly, function reliably, be error-proof and of course become ever smaller in size. Trelleborg also continues to strive to make all components as aesthetically pleasing as possible, which allows them to be easily adaptable to daily routines.

Nollenberger added: "With newer generation combination products or prefilled medical devices such as prefilled syringes, insulin pump systems or inhalers, we have seen increased surface friction behaviour, break-away forces or something we call 'stick-slip' come into focus. All of the above plays perfectly to the advantages of LSR as a material and LSR technology which Trelleborg is offering.

"LSR lends itself perfectly to medical applications because it is inert, very pure by nature and very versatile in its use, lending itself to a broad range of application conditions. It is also ideal for a large variety of medical grades which facilitates specification choices, making it a preferred choice within the healthcare sector."

LSR covers a very broad temperature spectrum from -40°C to +250°C (-40°F to +480°F) and offers good chemical resistance to a wide range of fluids and chemicals.

As with any elastomer, it has limited pressure capabilities, but this is principally down to the specific design and application conditions. Service life, as with any other polymeric product, depends on each individual application.

As a liquid raw material, silicone offers advantages in processing that render it a premier choice of material for technical components in high volumes.

In addition, the material can be co-injected with a number of technical plastics into two-component solutions and into highly complex geometries, not possible with other elastomers."

TECHNICAL LSR O-RINGS

Trelleborg uses highly automated LSR technology for the manufacturing of high-volume precision parts with absolute consistency and very tight tolerances in flash-less quality.

Liquid silicone rubber moulded parts

The applications are very broad, from highest specification flash-less micro O-Rings for an inhalation pump system, an ultra-low-friction syringe plunger, through to a disposable multi-component valve for a sterilisation unit in the hospital room.

Nollenberger said: "When it comes to using LSR, even for something thought to be as simple as an O-Ring, the possibilities with a liquid raw material are bountiful as compared to other elastomers. The advantages of employing automated LSR technology become ever greater with more complex technical components, micro parts and/or parts with high geometric complexity including those involving multiple components."

Looking at one of Trelleborg's production cells through the windows of a cleanroom, one can see the example of a micro sized O-Ring, 1.4 mm by 1.1 mm, produced in a 24/7 mode in millions of pieces annually, with the material injected directly into each single cavity of a multi-cavity tool, without the witness of a flash-line nor visible injection point. This is a critical requirement in the application.

The parts are then removed from the cavities by a specially designed robotic gripper arm. As the parts are too small to engrave, for traceability the O-Rings are deposited separated by cavity into a specially developed container system.

LSR and 2C LSR moulded parts

2C LSR TECHNOLOGY

Nollenberger said: "One of our most outstanding capabilities is the simultaneous injection of LSR in combination with technical plastics, 2C LSR technology. One of the key advantages of this is the ability to mould several components into a single component.

"We use highly advanced, sophisticated tools and process engineering to develop the most innovative solutions, combining two, three or more individual materials into one fully bonded, robust component."

The main advantage of the combined

technology, commonly referred to as 2K, 2-shot, multi-component injection moulding, is the ability to produce high volumes – most efficiently greater than half a million pieces annually. For projects smaller in volume and, where simply a fully automated 2C process is not possible technically, Trelleborg generally turn to an overmoulding technique.

The main advantages of Trelleborg's 2C LSR technology means designers are given much more latitude in their design solutions, for example utilising space more effectively, saving or cutting out weight, or integrating extra functions.

They can also integrate multiple components into one fully-bonded solution and a single component is more robust than an assembly of individual parts. Typical risks and costs associated with secondary assembly can thereby be eliminated effectively.

Especially in the healthcare sector the criteria of hygienic designs is a key factor. The pioneering technology enables more hygienic design solutions by eliminating, for example, dead space through the use of a customised 2C solution versus a classic O-Ring sealed package. Lastly, a 2C LSR design solution can help to reduce the number of components in the customer's supply chain.

This ground-breaking technique offers a wealth of options for integration and miniaturisation, resulting in better and more effective solutions in the long run.

Micro components are visually inspected

RISING DEMAND

The simultaneous 2C LSR process is available in many hard-soft and soft-soft combinations, including multi-colour and multi-hardness options making it extremely efficient for high production volumes.

Nollenberger said: "We believe the potential of the 2C LSR technology capabilities is endless, and that we are just looking at the famous tip of the iceberg. We continue to demonstrate successfully and effectively how it can be applied across a wide field of industries and areas of application, and we continue to focus a lot of our ongoing research and development efforts in this area.

"These products are increasingly complex in design and functionality which is why we're seeing more and more manufacturers working with Trelleborg as their chosen supply partner. We can support them from the very first concept stage with critical design input from our side, which is so vital to the success of a new product introduction, right through to serial production on critical components."

The rising demand for technical solutions with LSR, including 2C technology, can be explained with such mega trends as urbanisation, demographic and social change, limited natural resources and more.

In the automotive industry, where the vision of the fully autonomous car means vehicles have more and more electronic features for either driver safety or comfort, sensors stand at the base of all of these features, with LSR technology offering itself with many favourable material and processing properties to serve in critical sealing, damping and protective functions.

Industry 4.0, with advanced levels of automation and connectivity processes, also require electronic features, and again sensor technology increasingly.

DESIGN PROCESS

Electronics and lifestyle products for the increasingly affluent parts of society – with modern home appliances and the vision of the fully connected home bear fruit to many areas of application for LSR. Wearable devices likewise, as their application comes more into focus for medical purposes.

In life sciences applications it is particularly important to counter the prominent challenge of unwanted bacterial growth and inherent impurities either by way of inferior material properties or unsuitable production methods.

LSR as a material, in combination with a hygienic product design including 2-component solutions, produced in a fully automated closed-loop production process and in a controlled cleanroom environment, offers the purest available product in manufacturing.

Working shoulder-to-shoulder with its customers, Trelleborg's basic mode of operation provides the very first concept stage all the way through to the end of the product life. To start with, Trelleborg's design team currently work with the customer's designers to either propose a black box solution or to value-engineer a customer's concept or existing product.

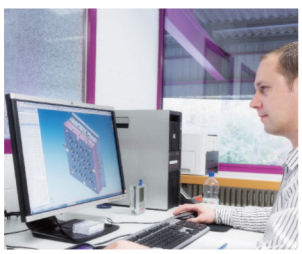
DESIGN FOR MANUFACTURE CRITERIA

In this phase, Trelleborg employs its well-proven Non-Linear-Finite-Element-Analysis (NLFEA) tool to model the behaviour of components under assembly and application conditions.

This improves design under functional criteria before the next stage of producing prototypes, using 3D technology or from a small test tool.

This step can also reduce lengthy trial and testing phases in case of multiple design options for the customer.

Trelleborg tool and process engineers step to the forefront at the prototyping stage



As a product design evolves, Trelleborg's tool design and process engineers in the production facilities focus on the manufacturing feasibility of the design. This is not just for prototype purposes, but equally for production purposes off multi-cavity serial tools, including the aspects of process automation and integrated process and product controls for quality and cost reasons.

Trelleborg's tool and process engineers step to the forefront at the prototype stage, agreeing with the customer critical tool and process concepts.

In the case of LSR injection moulded samples from a dedicated Liquid Injection Moulding (LIM) tool, a sophisticated flow simulation tool, is employed routinely to minimise the need for tool correction.

In this stage, such details as the ideal location and form of injection nozzle, and under what specifications the material is injected to guarantee the expected outcome, is determined.

Alterations to the tool construction can be made quickly before the actual tool is machined, thereby accelerating the time for first samples off a first test tool or later on a multi-cavity serial tool.

Everything developed and learnt during concept, design and prototyping facilitate all further stages toward small-scale and later large scale serial production.

The development process is accelerated for the customer at every stage by working with a supply partner, such as Trelleborg Sealing Solutions, that adopts a shoulder-to-shoulder engineering approach through all stages of a project with its customers.

FUTURE PLANS

Trelleborg Sealing Solutions supports its aerospace, industrial and automotive customers through over 20 production facilities and more than 40 marketing companies globally.

Nollenberger said Trelleborg plans to continue to push the boundaries and lead the way in the industry with continued investments in infrastructure and skill set at our global locations.

"We continue to push forward with tool, process and automation technologies to let us produce ever smaller parts, down to micro and now even nano-gram weights to enable the many ground-breaking and exciting technologies our customers are developing. Finding solutions to the so far thought impossible with LSR is what we thrive on.

"We are proud to be one of the world's leading developers, manufacturers and suppliers of high precision LSR and 2C parts and we intend to stay at the top."

Trelleborg Sealing Solutions
www.tss.trelleborg.com