Next-generation materials for impellers

Which material and process technologies shape the future of pump impellers? Sulzer's material and processing specialists are well underway to improving the operational security and lifetime of pumps with new materials.

Exploring and extracting oil and gas resources from offshore reservoirs forces the oil and gas industry to push its limits. More and more water injection pumps are used in deep- or ultra-deep water. There, the pumped fluids have higher temperatures and contain more corrosive substances.

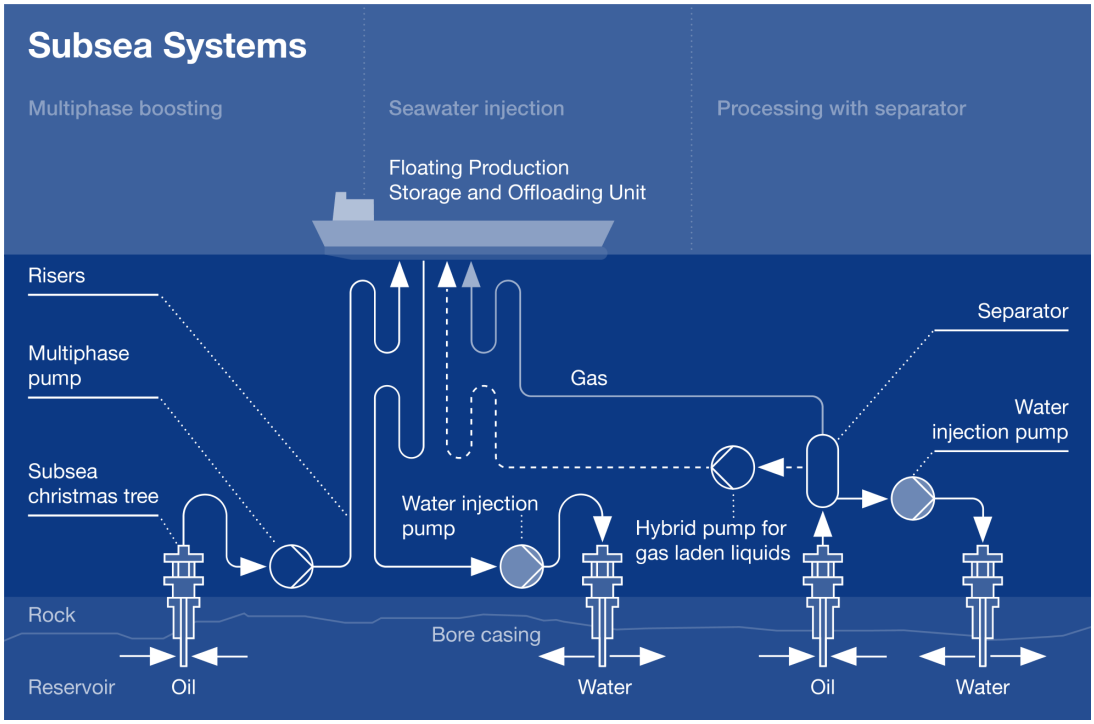
The deeper the reservoirs are, the higher the operating pressure needs to be. The pump must withstand a pressure of 1'000 bar (100 MPa). This can be expressed as a weight of about 1'000 kg acting on each square centimeter (14'500 pounds per square inch) of the pressurized area. Furthermore, the pump spins at 6'000 revolutions per minute (rpm) 24 hours a day, seven days a week, causing billions of load cycles per year on the impeller.

Improving corrosion resistance and strength

Deploying the appropriate material is crucial for the long-term performance and reliability of the pump.

Usually, super-duplex stainless steel is used as material for high-pressure water injection pumps. However, with a pressure of 1'000 bar, this steel reaches its mechanical limits.

The new material needs to be equally or more corrosion-resistant, and stronger than casted super-duplex stainless steel. Not an easy task, since material strength and corrosion resistance generally oppose each other. In addition, if you increase the mechanical and corrosion properties, it often influences the manufacturing method and increases production costs tremendously.



Evaluating new materials

Sulzer looks ahead to meet the future demands of high-energy pumps. Its material specialists constantly evaluate and test new materials and process technologies.

After having considered a wide range of new materials to produce impellers, the company's specialists selected a special nickel-based alloy as the material with the most promising potential.

In addition to the materials, our engineers needed to consider the manufacturing process of impellers. To reduce lead times, the specialists favored processes based on rapid technologies.

Day by day I'm inspired by the tremendous improvements we can achieve for our customers by working with new materials and processes.

Frédéric Lalanne, Division President Pumps Equipment

Testing different manufacturing processes

Sulzer's engineers compared a variety of processes against each other. Repeatability was one of the most important factors to guarantee material quality. For the water-injection pump impellers, the team chose vacuum investment casting as the preferred process.

After the casting process, hot isostatic pressing (HIP) is applied. This technology closes internal holes that naturally evolve during casting. By using HIP, the material becomes denser and thus more fatigue-resistant. As a final step, a specific heat treatment is used to further improve the mechanical properties.

Encouraging test results

The test results of the new nickel-based alloy material and the new manufacturing route are encouraging. As the material is currently not listed in any international material standard, the teams have to carry out a full-blown material characterization in addition to the standard material tests.

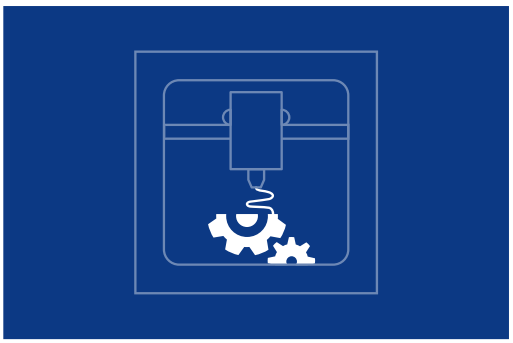
Sulzer expects the test phase to be successfully completed soon. Afterwards, the company will roll out the process for the production of water-injection pump impellers across the globe.

Once again, we have proved that we can overcome previous limits with new materials and manufacturing processes.

More stories about our products and services at www.sulzer.com/stories.

New materials for additive manufacturing

Sulzer makes use of new materials and additive manufacturing technologies for the production of pump parts.



New materials can be processed through conventional casting methods but also by additive manufacturing (AM) technologies. AM allows complex, high-quality parts to be manufactured in short lead times. It also results in improved mechanical properties and offers full freedom of design. This further expands the operating envelope of the equipment that we offer to customers.

Steeled for the future

Sulzer engineers came up with a new repair method for steam turbines in geothermal power generation. The improved welding technique uses 12% chromium stainless steel. It gives rotors running in harsh conditions an extended life.

In 2017, Asia accounted for nearly two-thirds of the global increase in renewable energy generating capacity, according to a report by the International Renewable Energy Agency. One important energy source is the heat from the earth: renewable geothermal steam from underground. Four out of the top ten biggest geothermal power plants in the world are located in Asia (Indonesia and Philippines).

In power plants, steam turbines are used to convert steam energy into mechanical energy. This energy drives a generator that produces electrical energy. Power lines transport the energy to homes and businesses.

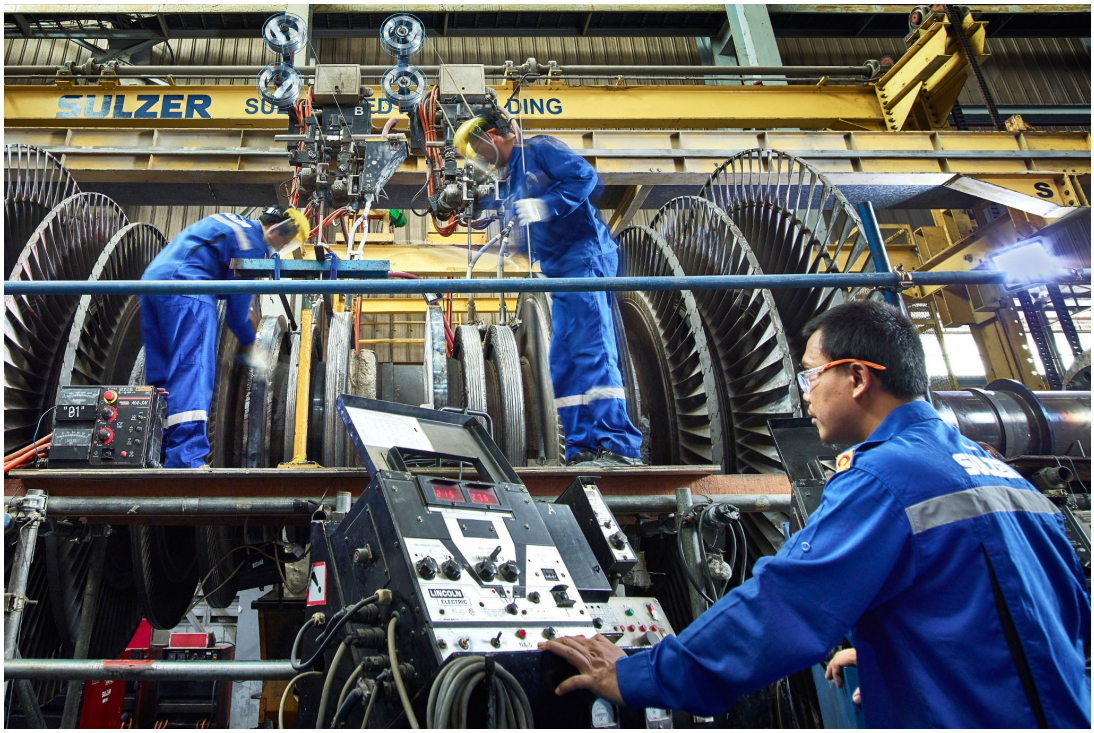
Innovation in the service business is part of our DNA. We improve our repair technologies and response time to optimize cost of ownership of our customers.

Daniel Bischofberger, Division President Rotating Equipment Services

Washed away by corrosion

Steam turbines operate under extreme temperatures and pressures. In addition, geothermal steam turbines work with steam that contains some very corrosive components. Because it is a natural process, they are variable and unpredictable. In practice, very substantial damage can occur over time due to corrosion and erosion, which can cause the areas exposed to the steam to be “washed away”.

The rotors used for these steam turbines employ a range of steels specially developed to retain their strength over a long operating life of 25 or even 30 years and to be corrosion-resistant.



Welding instead of replacing

The fast repair of critical rotating components is one of the main activities of Sulzer's Rotating Equipment Services division. Original equipment manufacturers often propose to customers the very costly option of purchasing new replacement rotors. Our Indonesian team saw a market opportunity to repair the rotors by welding.

In this process, an area of damaged material is removed and a large mass of weld material is used to replace it. The geometry is then recreated to finish the renovated rotor. This can be much quicker than ordering a replacement part because the long lead-time for new forgings can be avoided. Both the customer and Sulzer profit from the improved cost structure.

Collaborating for better resistance

The idea was born in 2013 at Sulzer Indonesia. A Philippine customer needed a rotor repair of a geothermal steam turbine that was showing cracks and stress corrosion.

The Sulzer team had some concerns about the weld material used at that time. A low-alloy weld wire for turbine rotor material typically has a high nickel content, which is likely to suffer corrosion cracking when exposed to a hostile environment. The Indonesian team consulted with Sulzer colleagues in the US and eventually came up with the 12% chromium steel (12Cr) weld wire option.

Extending rotor lifetime

The 12Cr weld has even greater corrosion resistance than similar alloys developed by the different rotor suppliers in the specific hostile environment where the geothermal steam is extracted from the rock. This means that in some cases, the 12Cr weld can actually give the renovated rotor an improved life over the original material.

The Sulzer Executive Committee recognized the innovative approach and exemplary collaboration of these two teams across a vast geographical distance by honoring them with a "Sulzer Innovation Award" in 2018.

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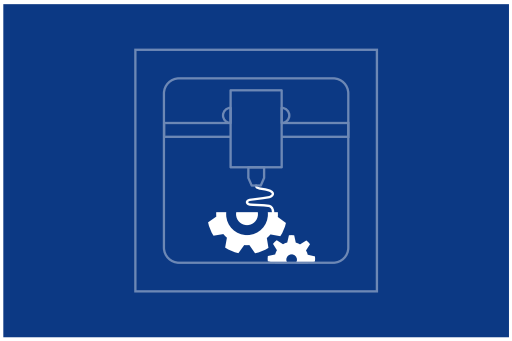
New ways to speed up delivery

Sulzer's Rotating Equipment Services division is finding new ways to shorten the lead times and increase the quality of the parts it provides to customers.



Rapid casting, where we print the patterns from which we cast the parts, creates supply chain flexibility. It also enables manufacturing closer to the customer's location. The division is gradually expanding its use of this technology within pumps services, region by region.

Leading technology for bio-based PLA plastics

Conventional plastics are usually not degradable. Polylactic acid (PLA) is a sustainable alternative: It can be used to produce plastics that are biodegradable. Sulzer delivers process know-how and key equipment for the production of PLA.

Common plastics take a very long time to degrade or are not degradable at all. This means that microorganisms are not able to break the material down into organic matter that living organisms can utilize. For example, a plastic bottle needs a stunning 450 years to degrade. Bottles made of PET will never biodegrade.

The sustainable alternative to oil-based plastic

Sustainable alternatives for these conventional plastics already exist. One is polylactic acid (PLA) that can be used to produce plastics that are bio-based, biodegradable and 100% recyclable to their original form.

With our technology, one of the world's top two PLA manufacturers built a large plant to produce 75'000 tons of PLA plastics per year. This is how we help customers deliver high-quality bioplastic solutions for a greener future.

Torsten Wintergerste, Division President Chemtech

The base material for PLA production is glucose or sugars from crops like corn, wheat, sugar cane and sugar beet – also called first-generation raw materials.

PLA is the most promising biopolymer based on renewable feedstock and has started to replace conventional polymers produced from fossil fuels. Its global capacity is expected to grow from 0.3 million metric tons per annum (MTA) today to one million MTA over the next five years.

From bottles to medical devices to 3D printing

Sulzer has played an active role in optimizing the PLA process for industrial use over the last 25 years. The resulting bioplastic has mechanical and thermal properties that are comparable or superior to its traditional oil-based counterparts.

PLA bioplastic serves as the base material for packaging (e.g. bottles, bags), textiles, components for the automotive industry, electronic devices, medical devices and implants, and 3D printing processes.

One-stop provider for PLA processes

Sulzer delivers single, key equipment solutions for PLA manufacturing. The company also designs and installs equipment and integrated modular solutions for the individual steps of the polymerization process.

At the customer's location, installation supervisors and start-up engineers from Sulzer provide support in the assembly, installation, commissioning and start-up of the equipment.

Building a PLAnet™ for sustainable bioplastics

At year-end 2018, Futerro, Sulzer and TechnipFMC teamed up to simplify the manufacture of bioplastics. The three major process technology and equipment specialists formed the PLAnet™ initiative.

The strategic collaboration will support investors from both ends of the sugar-to-PLA value chain in entering the bioplastic market. PLAnet is a "one-stop shop" for customers and is able to provide a single point of contact and responsibility.

Degrading at different speeds

One of the main benefits of the Sulzer technology is that the properties of the polymer can be adapted easily using the same equipment. There is no need for different process lines. This flexibility is important because the adjustable settings influence how fast or slow PLA-based products will biodegrade. For example, disposable applications such as food packaging with a short shelf life should be easily biodegradable, whereas electronic components need to be more durable.

The most important factor for a good polymerization is that the process temperature is maintained at a controlled, constant level and that the feed material is thoroughly mixed. Sulzer offers special mixer reactors, the SMR, that combine these two functions: mixing and cooling.

New generation of raw material

While feedstock-based materials work well for PLA production, they require agricultural land that is also needed for food production. This is why researchers try to find a new generation of raw material. One option is a material that stems from non-food sources such as agricultural residues (second-generation raw material). In its fully equipped laboratory in Switzerland, Sulzer runs tests and trials for customers. The results are then scaled up to industrial level for use in large plants.

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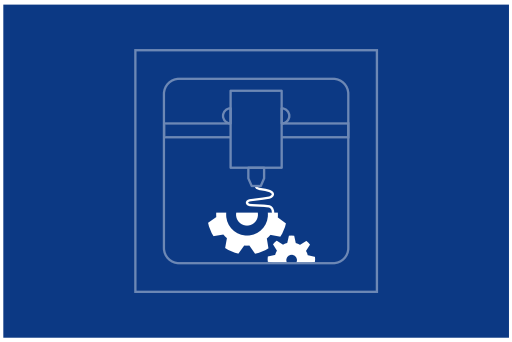
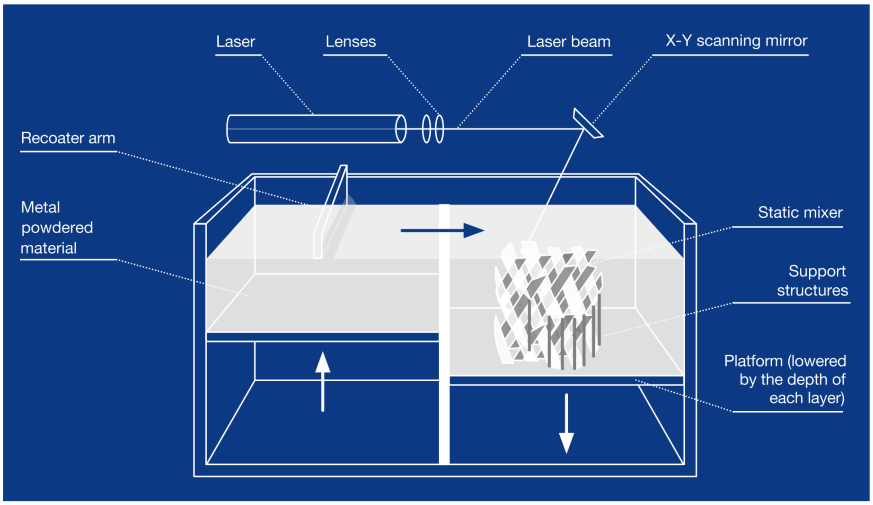
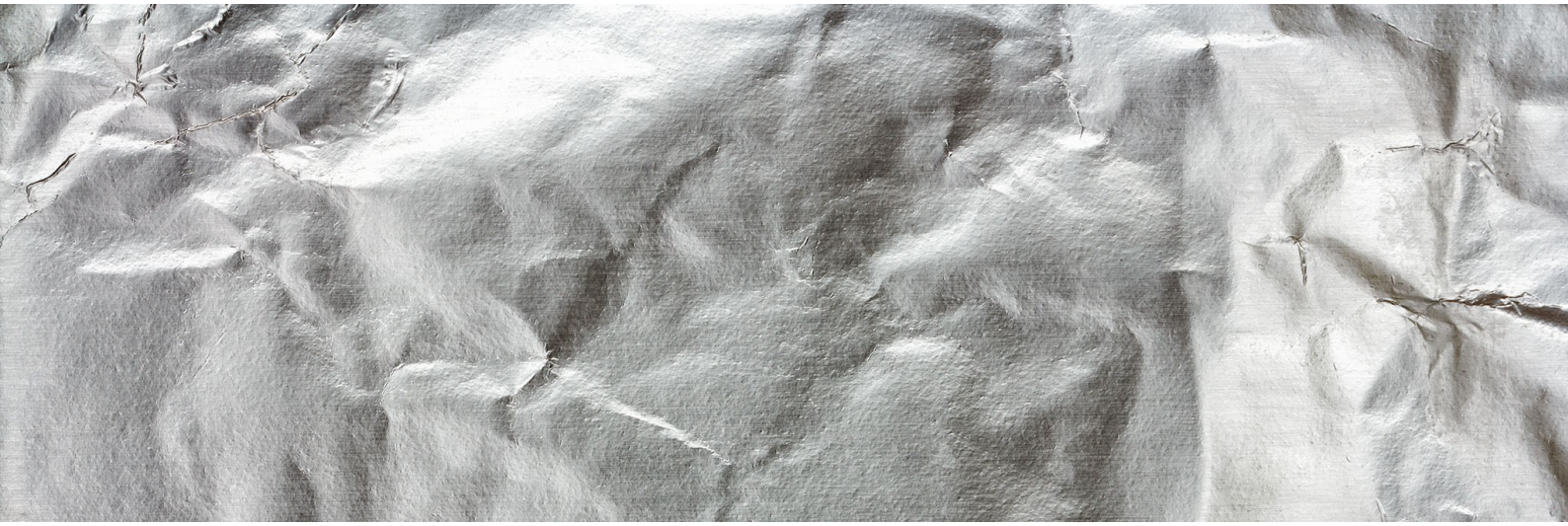
Fast lead times thanks to additive manufacturing

Sulzer uses a range of materials for its column packings, such as metal, polymers and composites. We are developing and deploying additive manufacturing (AM) technologies that are adapted both to the specific and to the variety of materials that we use.



We are producing small-scale static mixers by additive manufacturing, namely selective laser melting. By melting metal powder onto a platform, the product is built up layer by layer. Today, AM technologies are mainly used for prototyping, and to produce support parts, small batch size parts or tools. AM helps us achieve fast lead times, particularly for lower-volume production.





Pack it up – collapsible cartridges reduce waste and cost

Working with adhesives causes waste. Sulzer's Applicator Systems division has developed a packaging system that not only reduces waste but also reduces total system cost for customers. Introducing: the ecopaCC™ collapsible cartridge.

Adhesives, an invisible fastening technology, surround us everywhere in our daily lives. It is a technology used in many different industries. Adhesives provide various benefits – such as sealing and bonding of all kinds of substrates – that mechanical fastening systems do not offer. Adhesives are used in civil construction, for windshield bonding in your car and for bathroom sealing applications in your home, amongst many other uses.

Innovative solutions for waste reduction needed

Adhesives dispensed by cartridge-based packaging systems generate waste. The disposal process for residual material, transportation and storage contribute to higher costs.

National and international regulation increases on a daily basis. For example, the state of California in the US has introduced penalties for excessive use of rigid plastic packaging. The EU is about to release a new regulation to avoid plastic waste. The Japanese government has also started discussions to tackle the problem of plastic waste.

Next-generation functional packaging

Conscious of the ecological challenges to come, Sulzer's Applicator Systems division engineered a next-generation primary packaging for adhesives applications: the ecopaCC™ collapsible cartridge. The cartridge, which uses high-tech multilayer foils suitable for various chemicals, is collapsible and provides customers with savings across the entire value chain.

With our eco-friendly alternative to conventional packaging, customers reduce their costs across the value chain.

Amaury de Menthiere, Division President Applicator Systems

Conventional cartridge systems are disposed of once emptied. With the ecopaCC™, the only waste that remains is the collapsed foil and the small front part. Both take very little space. Moreover, the support sleeve for the cartridge is reusable and thus an important factor behind the ecological concept.

Significant cost reduction

Overall, customers can achieve significant savings by using ecopaCC™. For example, the transportation and storage cost of the empty, pre-collapsed 600 ml cartridge can be reduced by up to 85%, since seven times more cartridges can be packed onto a euro pallet. Additionally, once the cartridge reaches the end of its lifetime, waste disposal will cost our customer 75% less.

The new packaging system is designed to fulfill the highest quality expectations. The molding technology allows for a 100% leak-proof connection between the foil and front-end part. The system is compatible with our dedicated dispenser range as well as the static mixers.

Eco-friendly and ready to be certified

Sulzer has applied for the renowned EU Ecolabel for its new product. With more than 54’000 products and services on the market, the EU Ecolabel is well recognized. It is a very reliable and effective way to show consumers that a product or a service is both eco-friendly and of supreme quality.

The EU Ecolabel also opens up new business opportunities. B2B companies are facing increasing pressure to work with manufacturers of products that bear ecolabels in accordance to ISO standards in order to fulfill high-level supply chain requirements by customers.

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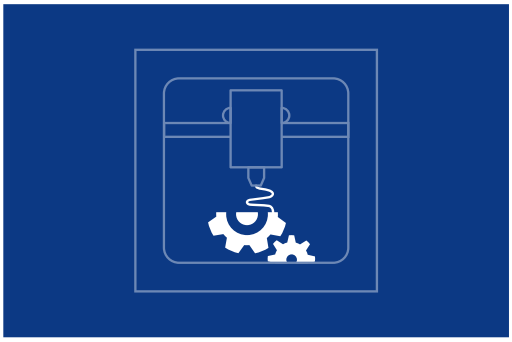
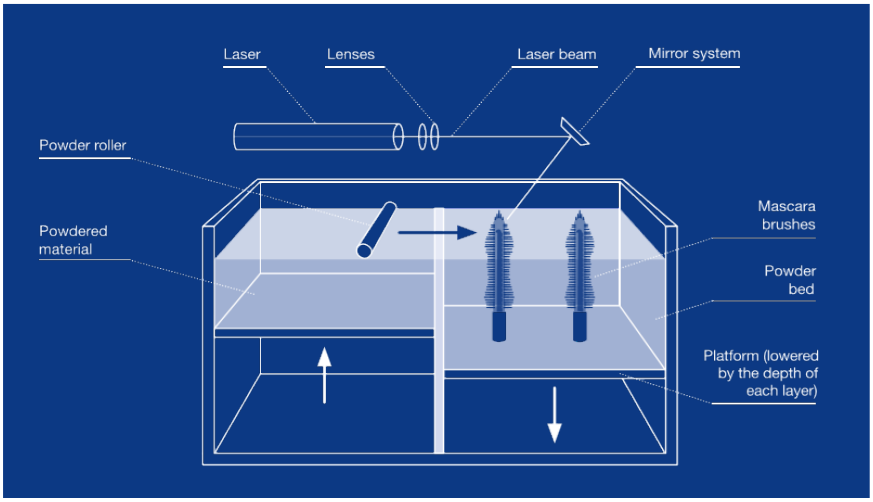
Additive manufacturing speeds up prototyping



When new products are launched, we want to deliver solutions to customers as quickly as possible. Additive manufacturing of smaller-volume components allows us to speed up the early stages of development before an expensive manufacturing tool has been built.

Thanks to additive manufacturing, Sulzer has considerably accelerated the development process and hence time to market of mascara brushes. We can deliver a prototype to customers within one week instead of 18 weeks. Thanks to a new material applied through selective laser sintering (an additive manufacturing technology) the bristles are stable enough to separate the eyelashes yet elastic enough not to hurt the eyes. In this way, the customer can actually test the prototypes effectively.



Functional principle of the selective laser sintering process, also called SLS.