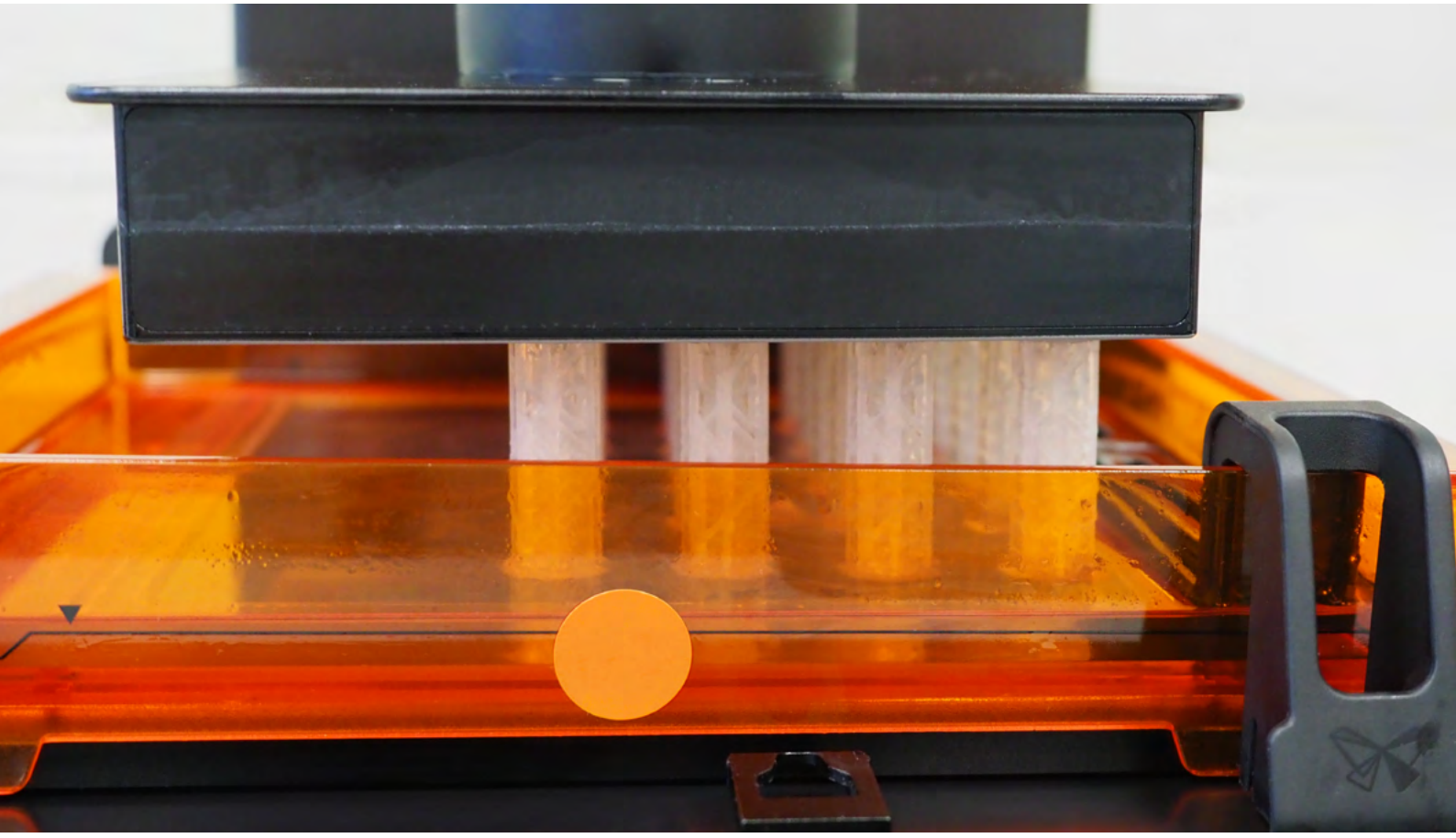

Additive manufacturing technologies at Sulzer

Additive manufacturing technologies and 3D scanning will massively change our future. As a technology pioneer, Sulzer evaluates additive processes and materials newly available on the market. Suitable processes are optimized by technical specialists, material experts, and process engineers, and tested in close cooperation with customers and partners.

In the early 1980s, the American inventor Charles Hull developed the first additive manufacturing process, which he called stereolithography. He applied for a patent for the principle in 1986. This invention paved the way for additive manufacturing (AM), also known colloquially as 3D printing. Sulzer started its development of the laser metal deposition process in the 1980s as an industrial process, obtaining patents during the 1990s. Today, lasers are established as the energy source during the process of AM for metals.

3D printing processes and technologies in the industrial sector

The various additive manufacturing processes are developed for specific materials (plastic, metal alloys, ceramics, sand, and wax). The method of consolidation (polymerizing, laser melting or sintering, fusing, UV curing, etc.) is specific along with the form of the material (liquid, powder, wire, etc.). As the technical maturity of the additive manufacturing processes grows, their use in industrial environments is becoming state of the art. Each technique is aligned to the place where it brings most customer value. One day we may see spare parts produced “just-in-time” on customer sites.

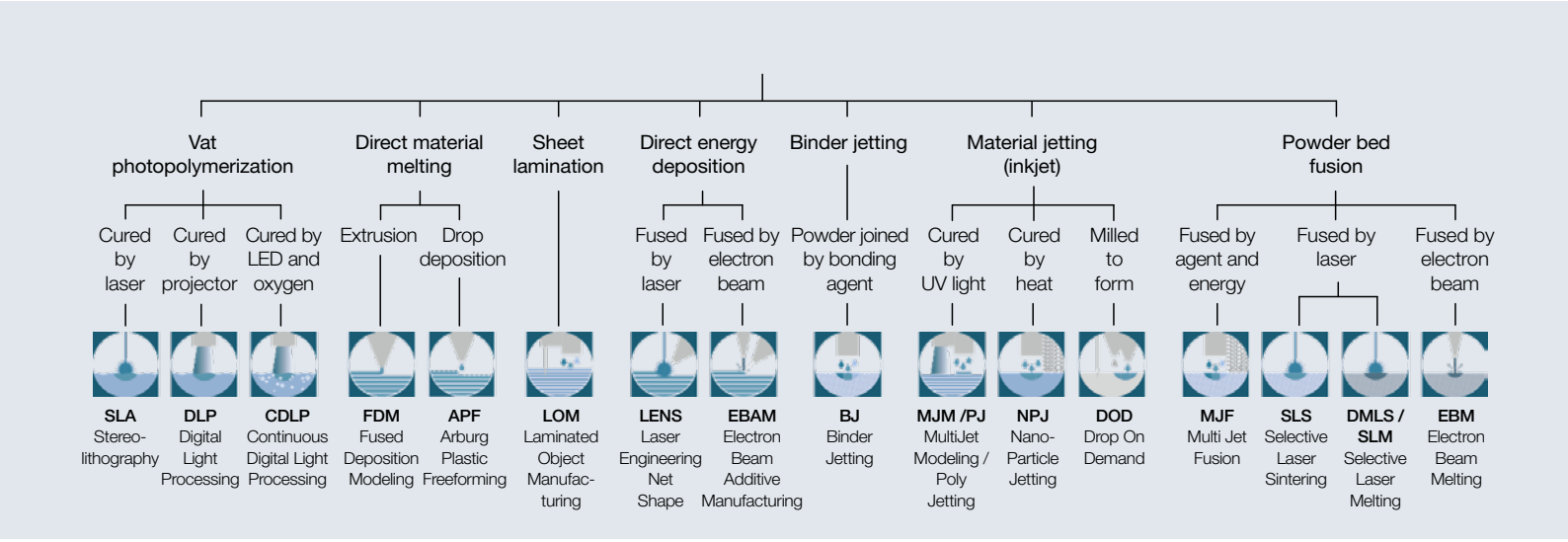

Fig. 1 Overview of the most important additive manufacturing technologies in the industrial sector.

Typical areas of application at Sulzer

Sulzer uses a variety of additive manufacturing processes in all divisions and for a wide variety of applications. “With additive manufacturing, small quantities or customized products can be produced quickly and cost-effectively,” says José Ettlin, development engineer in the strategic innovation department.

Sulzer uses 3D printing processes primarily for the production of prototypes or functional samples. Ettlin explains: “Product optimization with 3D printed prototypes greatly improves the functionality of our applicator solutions. At the same time, we can significantly reduce the time required for product development.” Sulzer Applicator Systems does not only use additive manufacturing technologies. We also supply packaging solutions for additive processes where two-component material is employed for accelerated processes.”

Printing laboratory in Haag, Switzerland

“Our goal is that our development engineers can acquire solid detailed knowledge in the field of additive manufacturing. That is why we have installed our own 3D printers in our printing laboratory. And our process specialists love tinkering with it, even after work for their own projects,” Ettlin adds. The 3D printed components were usually still too expensive for series production in the past. The potential of AM for individual, faster, and resource-efficient production drive the development of new materials, machines, processes, and IT solutions rapidly. More and more serial components can be produced directly with AM technologies in a cost-efficient way.

Fig. 2 Two stereolithography printers (left) and UV curing system (right).

Fig. 3 Fused Deposition Molding (FDM) printer working with red-colored PLA.

Most of the commercially sold 3D printers employ the Fused Deposition Molding (FDM) process. During this process, a wire-shaped plastic material is melted and then extruded. The FDM unit in Haag allows processing two different materials at the same time, which can have different material properties.

The two 3D printers, which operate according to the stereolithography process (SLA), are permanently in use. Short plastic chains are polymerized into long plastic chains by UV light and thus solidified. After hardening, the building platform is lowered. One squeegee distributes the polymer liquid evenly and the next polymer layer is formed with the help of the laser. After finishing the job and removal of the support structures, the finished components are cured under UV light.

Sulzer as early adopter

For geometrically complex components, additive processes are ideal. The Chemtech division started to produce static mixers from metal powder more than ten years ago, using the Selective Laser Melting (SLM) process. The components are solidified from metal powder in a bed layer by layer using a laser beam. Support structures are also used, which not only provide stability but are also used to transfer heat away. This prevents thermal stress in the workpiece.

“Sulzer Chemtech led the way in process development for the industrial production of high-performance polylactic acid (PLA). This bio-based and biodegradable polymer is used in numerous FDM printers (Fig. 3) for home use,” explains Emmanuel Rapendy, Head of Polymers and Crystallization. “It is a safe polymer – historically used in biomedical applications – requiring no particular safety precautions unlike other polymers when heated.”

3D printed parts for model pumps

“Additive manufacturing processes provide a fast and economical approach to assess the merits of different hydraulic design variants during model pump performance testing. The test results of the best hydraulic variant is reviewed against proprietary design rules and computational fluid dynamics (CFD) calculations. AM is currently employed in model pumps on stationary hydraulic components such as guide vanes and adaptation pieces, but also in some cases for rotating hydraulic components,” explains Arnaldo Rodrigues, Head of Hydraulic Development in Winterthur.

Fig. 4 Exchange of experience in the Additive Manufacturing Circle.
From left to right: Charles Soothill, André Brogli, Robin Rettberg, and José Ettlin.

Fig. 5
Additive build-up with Laser Metal Disposition (LMD).

Hybrid manufacturing for pumps

In hybrid production, a combination of additive build-up, using Laser Metal Disposition (Fig. 5), and a subtractive process, 5-axis milling, is used to rapidly make impellers with the new material properties and also achieve the required hydraulic surface quality. For closed impellers, the hybrid process is ideal.

Regular knowledge exchange

Sulzer has established an Additive Manufacturing (AM) Council to enable engineers from various Sulzer divisions to share their knowledge. Charles Soothill, Head of RES Technology and member of the AM Council, explains: “This exchange allows us to participate in the knowledge of other engineers. We also learn together across Sulzer about new finishing methods or new materials. What experience do engineers from other divisions have with 3D printing and hybrid processes?”

Soothill adds: “In addition to the optimization of our 3D designs, we can optimize materials and reduce costs. We are also looking to the future. What inspection procedures, test methods, and machine process monitoring are required to ensure the quality of the 3D printed parts? How can material defects be avoided? What features can be optimized when building up the structure of components? How can Sulzer use bionics and adopt examples from nature for lightweight design?”

Visions for the future

Pharic Smith, Head of Engineering in the Rotating Equipment Services division, explains: “Sulzer already uses additive processes for the rapid repair of complex damaged parts in the turbo industry. In future we see additive manufacturing also being applied to the rapid repair of pump parts to restore to as-new condition in short lead times. Functional and endurance tests are in progress for the creation of complete parts with additive processes to ensure high quality and repeatability. Once this is assured, we see enormous potential in these processes to offer our customers faster solutions.”

Nadia Qaud,
Winterthur, Switzerland

What are the advantages of printing spare parts on-site? Quick repairs without long downtimes. No storage, shipping, or customs complications. Sulzer is thinking intensively about new business models to make this vision come true and to offer our customers these advantages in the near future.