High Speed Sintering
as a 3D printing process

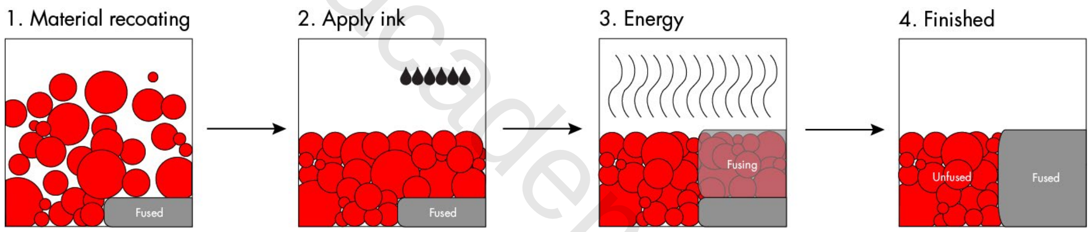
Whitepaper

Content

New, more flexible and economical plastic sintering process

Sintering has gained more and more of the market share as an industrial process in recent decades. However, a relatively new concept is plastic sintering with additive technologies. The background: More and more parts which previously would have typically been made from metal are now being sintered using plastic powders. This is because, especially in the automotive and aerospace industries, every gram counts when it comes to saving weight. Today, there are many different technologies available as alternatives to injection moulding. One of the most well-known of these is selective laser sintering (SLS). However, 3D printing expert voxeljet has successfully conducted research in this area and offers the High Speed Sintering process (HSS). A technical highlight is voxeljet's HSS control software, with which users can make precise, individual adjustments to any parameters, e.g. for hard or soft component properties. This applies to a wide range of plastics, for example PA12, PP, TPU, PEBA and EVA.

Process description: In the HighSpeed Sintering process by voxeljet, a thin layer of plastic granulate is applied to a heated building platform. An inkjet print head then moves over the entire platform and applies an ink that absorbs infra-red light to those areas where the desired component is to be created. Once this is completed, an infra-red lamp radiates the building platform. The printed areas of plastic granulate absorb the energy, which causes them to melt. The unprinted granulate on the other hand, absorbs hardly any energy and remains unbound. After the sintering process is complete, the building platform is lowered by one layer thickness, and then the next layer of plastic powder is applied, printed and radiated. This process is repeated until the component has been fully constructed. Finally, the sintered parts are cooled in the temperature-controlled building area to a predetermined temperature. The entire job box can then be cooled outside of the printing system and the next job launched. After cooling, the desired component is removed from the powder and subjected to a finishing treatment, such as surface smoothing, before it is ready for use. The remaining powder is processed and reused.



Open source software for maximum flexibility in the sintering process

The 3D printing process is controlled by the new control software developed by voxeljet: ProPrint. What is special about this open source solution is, that the customer can freely customize all of the most important parameters for their own material requirements and adjust them to their optimum settings. ProPrint allows free control of the energy input which melts the printed granulate. The layer thickness and ink input can also be configured individually as well as many further parameters.

Summary of benefits:

› Individual configuration of the temperature sources.

› Freely adjustable recoating speed, layer thickness etc. to fine tune the printing process..

› Varying powders with grain sizes of 30 micrometres up to 1.3 millimetres can be processed.

› IR lamp passes can be defined for firmer or softer component properties.

› Variations of applied amounts of ink.

› Process data can be individually analysed, evaluated and programmed.

› Full access to the printing system's telemetric data.

› Bitmap-based printing. This allows the user to access the individual print layers (streamlining).

› Irrespective of the alignment of the components within the job box, components have isotropic surfaces in the direction of the X, Y and Z axes.

Vast material freedom: granulates from over 20 platics manufacturers can be sintered

With HSS, voxeljet already works with plastics ranging from polyamide 12 (PA12) to polypropylene (PP), thermoplastic polyurethane (TPU) and ethylene vinyl acetate copolymer (EVA). This variety of materials means that practically any conceivable plastic properties can be realized for prototypes and functional components. One of the first companies to adapt the HSS technology was the chemical expert Evonik.

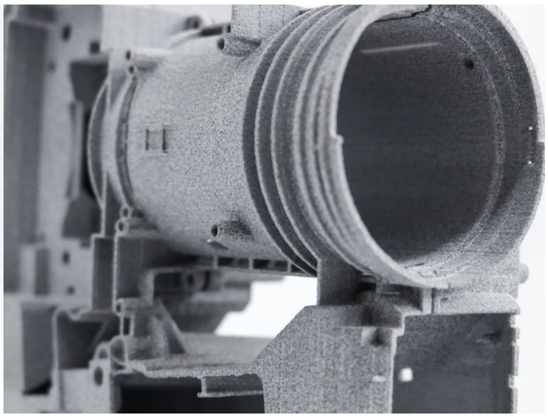
„The HSS technology from voxeljet allows the interaction between material and machine to be optimized and thus the offering of the best possible product," says Dr. Silvia Monsheimer, Head of Market Segment New 3D Printing Technologies at Evonik. Due to the large variety of materials that can be processed, the application possibilities are enormous. With PA12, for example, you can create functional prototypes, minicomputer casings or car interiors. Polypropylene (PP) is one of the most widely used plastics. Chemically resistant and hydrophob it is suitable for car interiors, wire and cable sleeves, or fittings. The elastic TPU can be used for inner and outer shoe soles, precision seals, rollers, bushings etc. EVA is also widely used in the shoe industry. The material is also suitable for household and garden packaging or flexible hoses.

Material validation in a short time: material testing offer makes it possible

Enquiries about materials can also be sent directly to voxeljet. As part of its Material Testing Offer, voxeljet will draw up a proof of concept in its Material Certification Lab and test whether the desired poweder is suitable for the HSS process. In just 40 working days, voxeljet will not only qualify the material, but also the required process parameters. If the 3D printing process proves to be successful, the customer will also be sent first demonstration models. The qualified parameters can be freely used on all HSS systems.

HSS versus conventional Injection Moulding

Injection molding and High Speed Sintering involve two different production concepts: “Design for Manufacturing” with injection molding, and “Design for Functionality” with sintering. With HSS, the components can be optimized with regard to functionality and endurance. Injection molded parts, on the other hand, must be optimized for mass production, in other words, geometrically much less complex, which is why under-cuts, for example, are not possible with injection molding. High Speed Sintering, on the other hand, enables highly complex geometries and also provides significantly better resolution. This is particularly important when producing, for example, slats or textures. Tiny gaps or spaces cannot be created using the injection molding process. However, for larger batch sizes HSS is not yet as economical as injection molding. If components are to be produced in large quantities and geometries are rather simple, it is worth to manufacture an injection mold. Nevertheless voxeljet´s research and development department is already working on a more economical form of technology with larger building volumes and and proportionally faster layer times.



HSS versus Laser Sintering

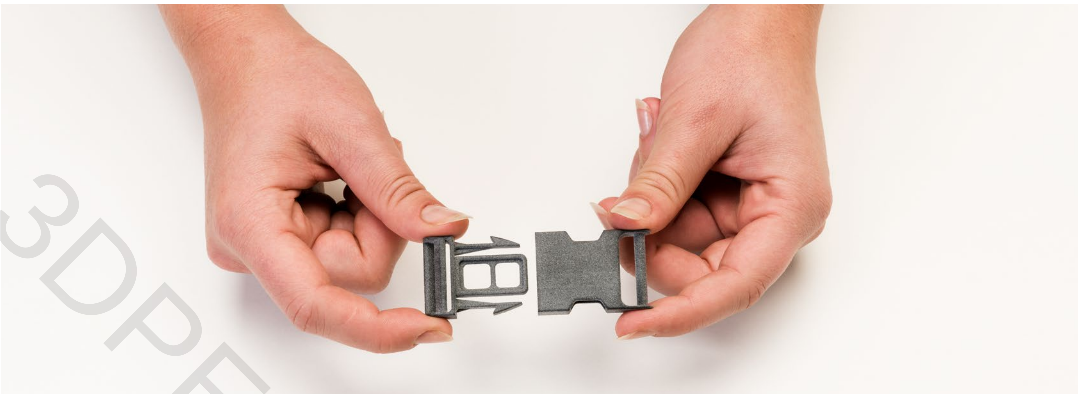
The advantages of HSS compared to Laser Sintering (LS) include consistent layer times and the easier thermal management, as well as the freedom to create a wide range of geometries alongside each other in one printing process (“job”). This means that large components can be printed directly alongside more delicate components with a higher level of complexity. However, the laser used in the LS process, has to punctiform print the entire building platform. With the LS process it is therefore only possible to produce a vector-based mesh alongside a solid cube to a limited extent and only under very specific conditions. During nesting, the digital preparation of the Job box, HSS allows the user to make maximum use of the capacity of the job box (up to 15 % job box utilization) and increase economic efficiency. Furthermore, due to its wide inkjet printheads, the printing speed is much higher with HSS: 54,600 square millimetres printed per second in High Speed Sintering, compared with just 1,750 square millimetres per second with laser sintering. However, laser-based systems can reach much higher temperatures than HSS. This results in a currently greater variety of materials, since high-temperature plastics such as polyether ether ketone (PEEK) and other polyaryl ether ketones (PAEK) materials can be sintered.

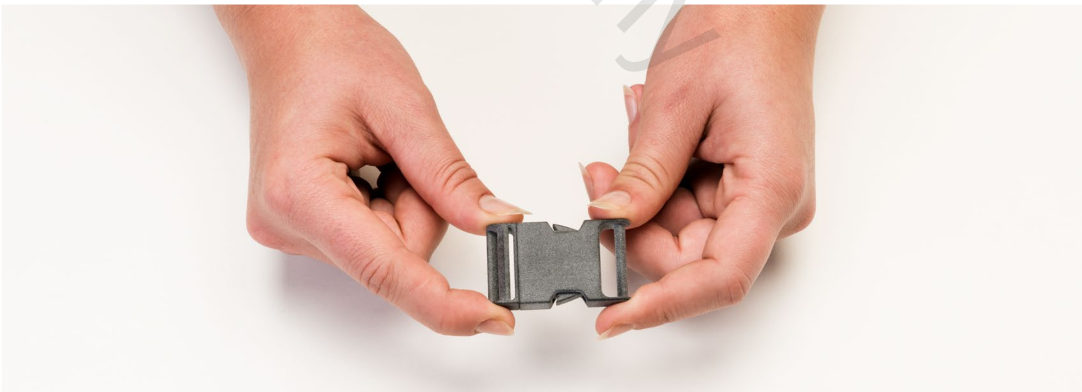
Key features of HSS

voxeljet relies on the use of an industrial, piezoelectric inkjet print head and an oil-based ink for its HSS process. Paired with an advanced IR lamp technology, a highly accurate edge definition is achieved. This technological combination facilitates the temperature management of the construction process. The precise filtration prevents the filament of the lamp from burning through and increases the service life of the lamp significantly. A further positive effect is the simplified unpacking of the components.

Other printhead technologies allow resolutions up to 1,200 dpi. But in the end the average grain size of the powder is the limiting factor for the actual resolution (typically 55 micrometres in PA12). During printing, the gaps and touchpoints of the individual grains must be dyed to allow the material to be sintered. The inkjet head in HSS provides a resolution of 360 dpi. This means a droplet is only slightly larger than a 55 micrometre PA12 grain, and therefore can completely coat it in dye. Inkjet printheads have been around for over 30 years. In combination with oil-based inks, these printheads are characterized by a particularly long service life and low wear. The oldest print head at voxeljet has been in continuous use for over four years.

Nevertheless, the inkjet printhead technology can also be used for water- and solvent-based ink printing. However, oil-based inks have other advantages in addition to low wear: they enable a much greater variety of materials. For example, hydrophobic polypropylene (PP) can be processed much more easily with oil-based inks.





Conclusion

The additive manufacturing of polymers will continue to gain importance in the future. But even if building spaces become larger, workflows continue to be harmonized and material diversity continues to increase, it will never completely replace conventional injection molding. But depending on component geometry and production volume, 3D printing represents a meaningful extension. The HSS process will prevail in particular with regard to the individualisation and optimisation of components and materials. The combination of geometric freedom and material diversity will change the world of polymers as we know it today in the long term and help to optimise products with regard to the required resources.

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