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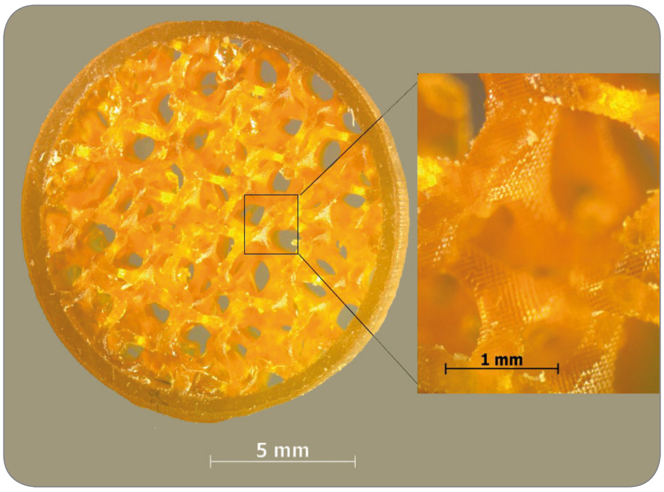
3D printing with maximum precision and strength

Components from a 3D printer with the best physical properties and highly smooth surfaces

Products from today's 3D printers often have problems such as ‚rough' surfaces and weak physical properties – like impact resistance and flexural strength. This still leaves much to be desired in comparison to traditional injection moulded parts. Prototypes today are often manufactured in the correct shape, but without the desired physical characteristics of the product. Furthermore, conventional 3D printers cannot produce the level of complexity required for certain components. 3D-printers use an additive manufacturing (AM), which distinctive in that both the geometry and the material properties are generated simultaneously during the production process. Today's AM-technologies allow for the direct conversion of 3D CAD data into a physical component, as long as they are not too complex.



3D printed cellular polymer structure

Objective

The research group headed by Prof. Jürgen Stampfl at TU Wien specialises in the development of new materials for 3D printers and has also developed its own 3D printer. The main objective of the research was to achieve the optimum surface quality with both tough polymers and high-strength ceramic components. Even highly complex 3D geometries can be produced by the new TU Wien 3D printers in a manner that is economical with resources and produces no waste. In this way, it is possible to produce prototypes, single items and small-lots , which reflect the properties of items produced by traditional manufacturing methods. In this way, functional and design errors in AM prototypes, which would be costly to correct at a later stage of development, can be identified early. The processing of impact resistant materials with similar properties to ABS thermoplastics (ABS-like) is also particularly important. TU Wien has a wealth of experience in this area. In addition, the scientists are also conducting research into complex structures - for example fine cell structures - that have not been realized by using conventional manufacturing processes until now.

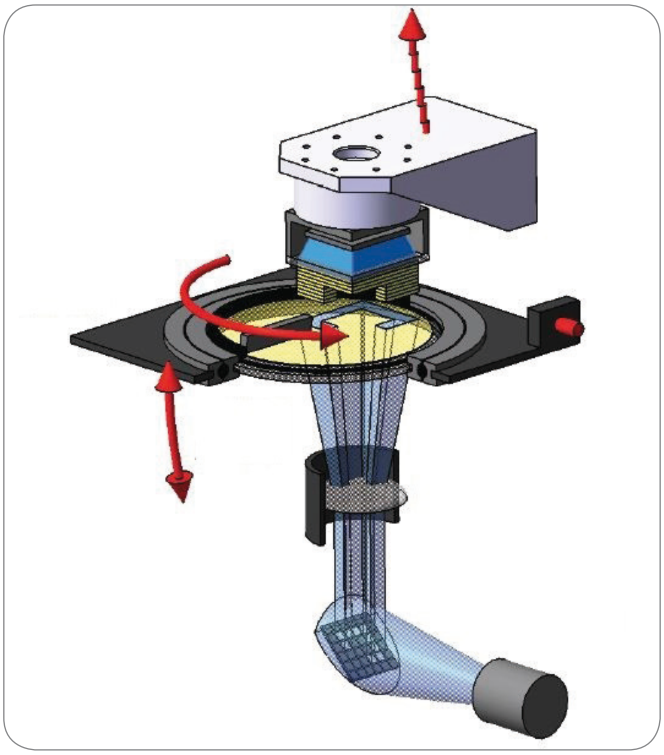
Approach

The 3D printer developed by TU Wien features a lithographic process that provides a solution for the processing of different materials, such as ceramics, polymer and bio-degradable polymers, using a hardening process which is based on light. A photosensitive resin is used which forms a solid polymer, when exposed to light. Stereo lithography (SL) is used, thus a laser doesn't scan the area to be exposed to light, but an entire plane of the structure is exposed simultaneously and thus cures at once. The greatest advantage that stereo lithography (SL) holds over other AM processes lies in the high resolution.
The 3D printer developed at TU Wien works with light at a frequency of 460 nm and uses dynamic mask exposure by means of DLP projection (Digital Light Processing). Adaptation for other light frequencies is possible.

Results

The 3D printer developed by TU Wien is able to process aluminium oxide, zirconium oxide, bioglass® and tricalcium phosphate. It is possible to produce cellular structures with wall thicknesses of 300 µm at a resolution of 25 µm!

Individual bone implants that have cell structures with defined channels of approx 0.2 mm and controlled porosity can be structured in one piece (Scaffold). The biaxial strength in ceramic components reaches the same value as in conventionally produced components (500 MPa). Using Al_2O_3 a density of greater than 99.6% can be achieved.



3D printer developed by TU Wien (principle scheme)

At the same time this technology provides more design freedom and less waste compared to established processing techniques (eg, injection molding, and milling) in the design of customized products - such as implants. In a similar manner, polymer components can also be produced with significantly improved physical properties. Currently, structures with a lateral resolution of 25 µm can be generated, with a layer thickness which lies between 25 and 100 µm. The construction volume is currently up to 115 x 65 x 160 mm.

Joseph Haydn – 3D printed, made from Al_2O_3

Benefits for you

- Production of precision components with high resolution
- High speed production achieved through the use of the DLP process
- Complex geometries can be produced directly from CAD files in a resource-efficient manner
- 3D printable polymer materials with high impact resistance
- 3D printable ceramics with highest biaxial strength
- Small-lots or differing single items can be manufactured in parallel production
- Products with excellent physical properties (comparable to series production by injection moulding), but without tooling costs.

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