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Additive Manufacturing Ceramics for Education and Research

3DCERAM

Highly specific properties of advanced ceramics make **ceramic additive manufacturing** more and more adopted by different players in many different applications: biomedical, jewelry, space and aeronautics, different industrial segments (energy, chemistry, oil & gas, water treatment, electronic, automotive etc...).

All these applications are prepared upstream by R&D works, implemented either by universities and specialized schools or by dedicated departments of industrial companies. Education and research are a springboard for the introduction of additive manufacturing into industrial mass customization.

Some requirements are identified for this specific segment. Possibility to prepare a feasibility study to meet the projects goals, easy use and maintenance of equipment are on top of the list of priorities. Acquisition of design and printing skills is a major challenge to succeed. So, efficient training becomes of primordial importance to print in efficient way.

And last but not least, the possibility, and, particularly for industrial companies, to easily scale up the results of R&D works to mass customization is important for a quick development and the introduction of new disruptive applications.

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Our ceramic expertise at your service

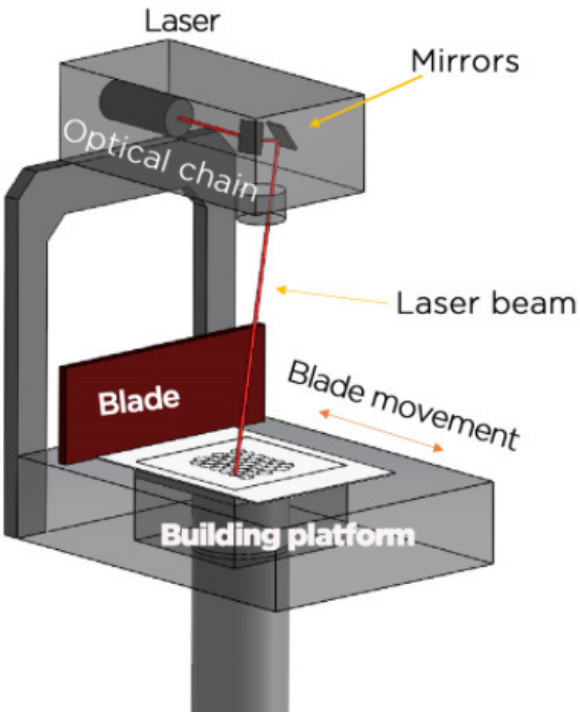
While preparing to launch the C100 Easy printer, 3 years ago, we set up a dialogue with our potential customers. Among them were some universities, research labs and R&D centres in various countries. These users clearly identified the following expectations from the new device and its supplier:

- Technical evidence that **the technology is suitable** for their projects is highly important to get these projects approved
- The equipment has to be **easy to use**;
- The printer system has to be opened for a **laboratory mode**;
- The price of investment has to be low to meet **economic feasibility**;
- The **training of user** personnel and particularly of all new doctoral students is expected;
- **Maintenance services** availability is important;
- The large range of applications studied has to make the equipment suitable for several and **various printing tasks**
- Process support from the supplier is of critical importance
- Possibility to **easily scale-up to industrial equipment**
- Possibility to **create and develop** their own slurries

- **3DCeram is capable to address all these requirements with the new range of C100 Easy printers: C100 Lab, C100 Fab and C100 Hybrid:**

- **Printing platform 100 mm x 100 mm x 150 mm**
- **Light source: UV lasers 405 nm of wavelength**
- **Laser spot diameter: about 60 µm**
- **Layer thickness: from 0.025 to 0.125 mm**

How does stereolithogaphy work?



The parameters have a laboratory mode and very large range of possible formulations viscosity for your newly developed materials: the CERAMAKER printer is a tool, which really reduces constraints for all your development works!

SLA technology advantages

Our CERAMAKER printers are using the SLA process with a UV laser on the top, which is, in our opinion, the best option to print efficiently high-quality parts with high homogeneity. The laser has a constant power output over the whole surface of the printing platform. This leads to excellent homogeneity in green porosity and to homogeneous shrinkage during the sintering (by opposition to other technologies where some internal stress may be created during the printing, which will then cause cracks during the thermal process or even during the use of the part). Our CERAMAKER printers are characterized by:

- High stability of formulations: no sedimentation, no ageing during the printing process. The wide viscosity range and stability of the slurries provide a significant flexibility for our customers to develop their own formulation.
- No intra-layer porosity in printed parts thanks to the homogeneity of UV laser power installed on the top. An optional camera can be proposed to monitor the right application of the formulation, layer by layer from the inside of the machine, during the printing process.
- Printing with contactless supports or supports, which need a very few points of contact. This also reduces the risk of cracks generation.
- Low viscosity of the cream, which makes it much easier and faster for the cleaning process
- Low cream consumption: for the majority of parts design almost 97% of the uncured cream may be re-used!
- The possibility to manually start a printing with very low quantity of formulation. Some cubic centimetres of the cream is enough to print!

Testimony

One of our customers specialized in research witnesses:

"The CERAMAKER printer, which uses the SLA process with a UV laser on the top, and the CPS software is well adapted to the manufacturing of quality ceramic parts. The different suspensions, oxides and non-oxides, are developed to build parts with high efficiency thanks to the great flexibility and possibility to configure. The open system software allows us to define lots of presets with various building parameters. It is quite intuitive. In addition, the CERAMAKER printer is very useful to develop new curable systems with low volume of materials (powders, binders, organics etc..), which is very important for a laboratory and particularly for expensive raw materials"

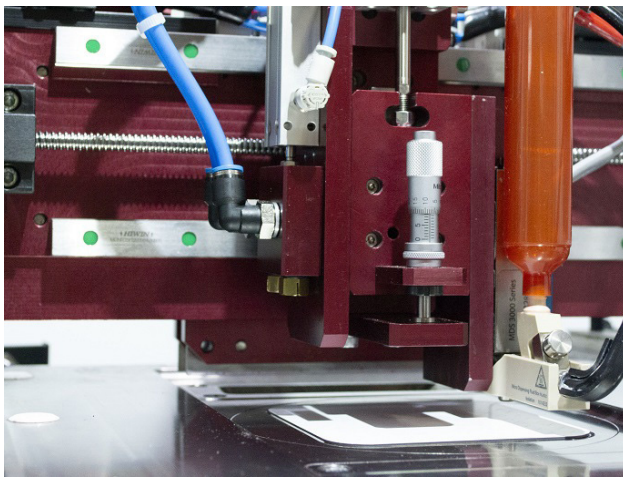
C100 Easy serie printers

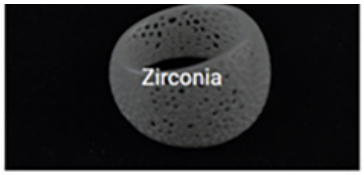
C100 EASY LAB is not only easy to use and to print parts on rather big printing surface in a very playful way but it also opens opportunities for R&D to develop materials and work on new designs:

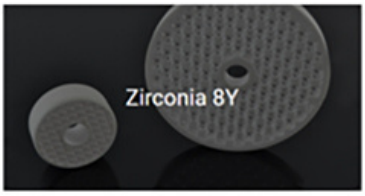
- Laboratory mode parameters
- Easy design of supports with Build-It (plug in of our software CPS)
- Very small quantity of materials needed to start printing
- Same interface and same consumables than the C3600 ULTIMATE mass customization printer
- Efficient remote online training

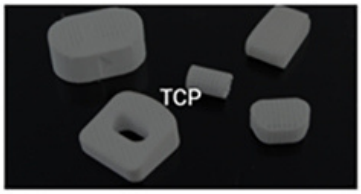
C100 EASY FAB has the same features and is additionally equipped with a pressure tank for the ceramic formulation in order to make it optimal for intensive printing use.
Both versions can be upgraded and further equipped with multi-materials printing module.

3DCeram also offers the **C100 EASY HYBRID** printer capable to print with a second material in addition to basic ceramic cream. The deposit of the second material is adjustable according to Customer's needs. Dispenser system for additional material is composed from a micro dispensing nozzle to feed the metal, resin or other ceramic cream and from the air blowing system nozzle. Hybrid functions are all integrated in the printer control system keeping same the ergonomics and easiness of use.









Silicore (zircon silica)
High mechanical resistance porous ceramic, very stable at high temperature, used with all alloys except cobalt, can be difficult to dissolve the core due to the zircon component.

HAP (Hydroxyapatite)
Non resorbable material used in the biomedical applications for the manufacture of the osseous substitutes, chemical composition close to bone, osseointegration (For example, tibial osteotomy wedges, invertebral cages, cranial implants, bone substitutes, spine implants, orthopedic implants, etc.)

Choice of material

The choice of ceramic is a very important part of the 3D printing process and is in close connection to the final parts properties we look for. C100 EASY printers' users may either develop their own ceramic formulations, use our standard creams or order from our 3D Mix on Demand service to develop new formulations based on their ceramic powder using our almost 20-years' experience in advanced ceramics development.

3DCERAM has been developing its portfolio of formulations, 3DMix, to use on the CERAMAKER C100 EASY and C3600 ULTIMATE, to achieve optimal printing results. These formulations provide a product equal to traditional methods.

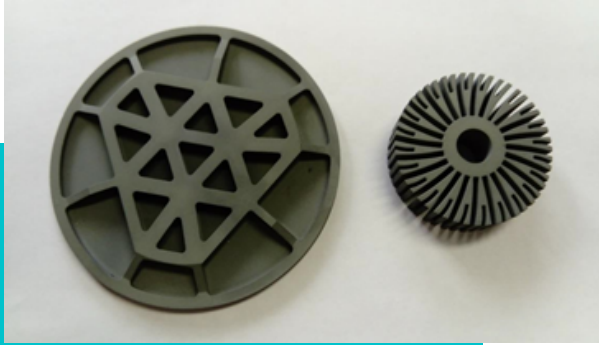
3DCERAM have optimized their materials according to the customer's criteria in many cases, in the form of on-demand development of ceramic materials to conform some specific Customer' requirements. This has allowed customers to use their own certified ceramic powders while using the breakthrough technology of ceramic 3D printing.

The following ceramics are available from 3DCERAM for C100 EASY AND C3600 ULTIMATE:

Alumina (Al203)
The most standard of advanced ceramic. Very good mechanical resistance, electrical resistance, high hardness, corrosion and wear resistance, high operating temperature and chemically and bio- inert.

Zirconia (ZrO2)
Useful in surgical instrumentation and odontology prosthesis (crowns and bridges), porous coating dentistry: material with very good mechanical properties, great hardness, good wear resistance, corrosion resistant

Silicon Nitride
One of the hardest and most thermally resistant ceramics. The main characteristics of silicon nitride are: low density, excellent resistance to thermal shock, excellent resistance to wear, and low thermal expansion coefficient.



Customized materials

Along with the materials listed here, 3DCERAM can also provide on demand services when a client wishes to develop their 'own' cream for the CERAMMAKER® range of printers. Our team of experts will take into consideration the needs and demands of the customer when creating a new formulation. The process to obtain a new formulation is:
Characterization of their powder
Test the reactivity of the material once mixed with resin.
Optimization of the powder and determination of printer parameters.
It is essential to offer the knowledge and expertise of the 3DCERAM Team to potential customers to establish a synergy between the parameters of the machine and the characteristics of the ceramic powder required to produce the desired outcome.

To Conclude

Ceramic 3D printing is a way to create breakthrough designs and improvements for both technical and business aspects of unique ceramic materials.
According to Smartech recent analysis, industrial 3D printingis expected to represent a large revenue opportunity during the forecasted 10-year period 2020-2030. There is an encouraging shift from research to scale production of technical ceramics. But such growth also needs upstream preparation of users and technologies.
Education and Research are at the front line of this challenging development.

About 3DCERAM-SINTO:

Created in 2001, 3DCERAM (www.3DCeram.com) is a company based in Limoges, France owned and managed by Christophe Chaput and Richard Gaignon since 2009. In 2018, Sintokogio Ltd. of Nagoya, Japan, industrial group of 4,000 employees with the turnover of 1 Md€, acquired 3DCERAM.

In late 2018 the decision was made to expand into the North American market by establishing 3DCERAM Sinto, Inc. in Wallingford, CT, USA. 3DWuhan in China was created also in …

3DCeram has un-paralleled expertise in the technology of 3D printing, offering a complete package by accompanying their clients on their chosen projects, choice of ceramic, production specification, R&D, modification of 3D parts with support to full industrialization, on demand production, the selling of the CERAMAKER® C100, C900 and C3600 printers, the production support accessories and the associated consumables.