

3D-Printing Ready for Industrial Scale?

For more than 10 years, 3DCeram based in Limoges/FR has been using SLA 3D-printing to produce functional and structural ceramic parts. The company is building on peerless experience to propose a comprehensive set of solutions to its customers, and is looking forward to opening up new markets for ceramics. Richard Gaignon (RG), CEO 3DCeram, reviewed the developments of the first decade and outlined his visions on bringing this technology to the market fast and on an industrial scale.

CA: What is 3DCeram's approach to further developing 3D-printing in technical ceramics for functional and structural components?

RG: 3DCeram started to print and sell 3D-printed ceramics in 2005.

At the beginning, back in 1998, we were quite happy to manufacture parts without moulds, without machining but just with paste, a printer and a kiln. At that time, just showing parts printed from a file (the famous idea of fast production) was enough to amaze people.

But pretty soon it was no longer enough to show parts or objects. The market wanted "reliable" products and not just dog and pony show technology.

And this is the reason for our rapid development in many fields: 3DCeram was able to develop formulations with outstanding properties after firing in terms of porosity, strength and so on. Ceramists are often very conservative and don't want to use or buy "second" grade ceramic. They were and are interested in getting products with the same properties but within a shorter time and with a lower technical barrier compared to traditional technologies such as injection moulding or pressing.

Nowadays, ceramists expect more than "good material" for their product. They want to get the best of the technology in terms of shapes, properties of the parts and not only the properties of the material. To illustrate this let's consider a frame structural optimization for a semiconductor machine made from alumina (Fig. 2 a-c).

The customer specified: no sharp edges, a very smooth surface and excellent cleanability (ISO1 required). The maximum mass allowed was 800 g (initial mass: 1 kg). The natural frequency required should be increased to 1200 Hz (initial NF: 800 Hz). As one can see, this part isn't complicated. Very simple shape, not complex, but its structure has been

thought out to lighten the product, to strengthen it and simplify its assembly. Usually, this slice is made by assembling several parts made by injection moulding or pressing for instance. With 3D-printing, this design can be manufactured faster and without the need for assembly: ready to be used, saving time and thus money.

3D-printing has other advantages. It enables the production of stronger parts (reinforcement can be introduced wherever needed), lighter parts, possible with integrated water-cooled channels, with a back-to-back structure, and so on. The challenge for 3DCeram is now not only to get materials that meet technical requirements, but also to define a 3D-structure that gives the customer an advantage. Our slogan for the additive manufacturing formula is: get the best design for your application.

CA: Can customers use their own mixes?

RG: Indeed, ceramists' second expectation is to be able to use THEIR material, their alumina for instance, their special magnesia and so on. It is important for them in terms of marketing, but also to get the same properties as their existing products. This is why 3DCeram has developed a new offer to develop formulations from already used ceramic raw materials. This has received positive feedback from the market and especially from the raw material suppliers as well the technical ceramic manufacturers who are eager to print THEIR ceramic.

CA: How important is the cooperation of 3DCeram with raw material suppliers to enhance the efficiency of the printing



Fig. 1
Richard Gaignon,
Managing Director 3DCeram/FR

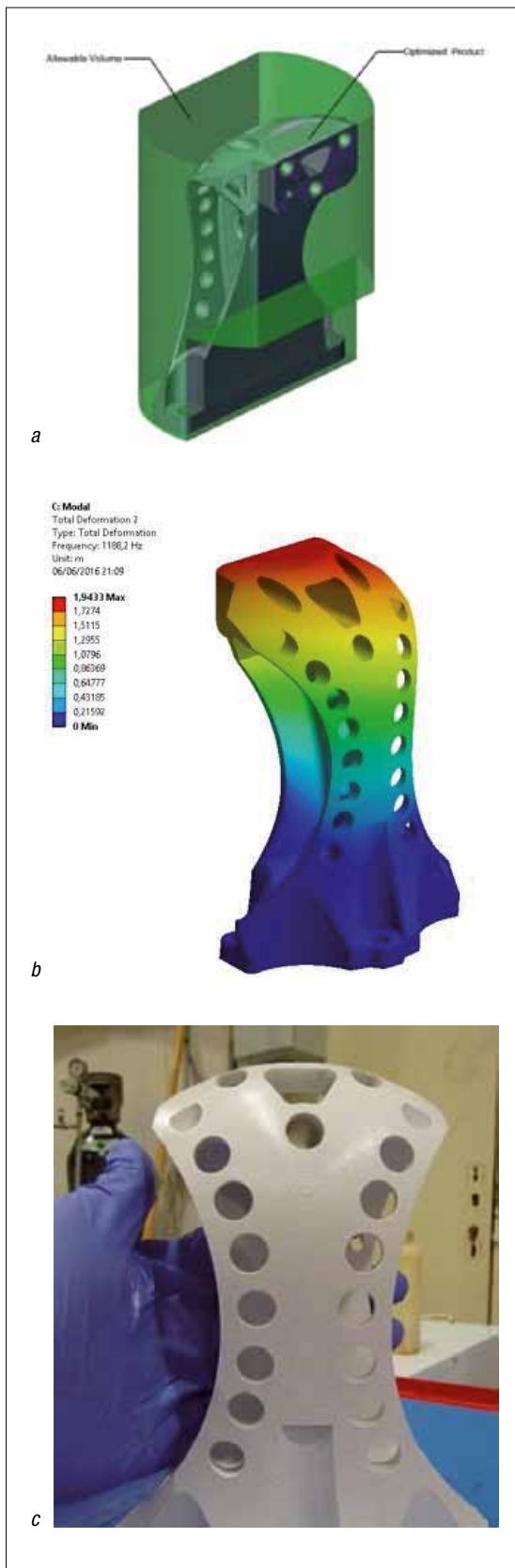


Fig. 2 a–c
 Redesign for additive manufacturing: frame structural optimization for a semiconductor machine: a) approach to optimized volume, b) model analysis of the part is a frequency representation of the structure stiffness, c) 3D-printed optimized frame

process and to ensure best technical properties of the final product?

RG: Ceramic materials have a wide spectrum: oxide, non-oxide; traditional materials and advanced ones. It is difficult to be at the cutting edge for all materials. If we consider that 3DCeram has a good knowledge of oxide materials, we also find out that we can go faster if raw material suppliers work hand in hand with us. 3DCeram’s most valuable knowledge is how to make a ceramic material printable. This is more or less difficult, but we know how to quantify it in terms of technical effort and physical modification (grinding for instance). But any physical alteration done in order to transform one material into a slurry or paste will affect its shrinkage, its physical properties after firing and so on. In order to resolve these issues and to get the best properties, the firing cycle may have to be modified or additives may be needed. By working with raw material suppliers, 3DCeram can offer a wider range of ceramic and thus more applications can get the benefit of 3D-printed ceramic. The difficulty with raw material suppliers is that they are always looking for big markets, huge volumes ... and 3D-printing is essentially a niche market that is getting bigger and bigger.

CA: There are plenty of R & D projects in ceramics, but manufacturers of technical ceramics need an approach to achieve at short notice an economic solution to meet their specific needs and make use of 3D-printing. What can be the entry gate for them to find the right system for their needs in short-run?

RG: I mentioned earlier that our first business model was to manufacture parts. In 2015, we decided to sell our Cera-maker machine, which is an open production machine (print surface of 300 mm x 300 x mm x 150 mm). But the question from our customer is not limited to “Buy” or “Make”. 3D-technology offers by far more freedom in the design of parts than injection moulding or pressing. People have to learn to think in “3D-technology” to be able to use it economically. 3DCeram can guide customers on this learning curve.

One important factor stops the customers buying parts: technical manufacturers don’t want to share their development idea with a third party. They want to keep it secret and to develop it internally. Therefore, with the German partner Rapidshape, we launched a desktop machine that can work with slurry. This is an excellent tool to understand what can be done with 3D-printing (get the code of this technology) and develop shapes that really are an advantage for their customer/application. For these first steps in this technology 3DCeram can supply slurries.

As any new technology, 3D-printing technology has to be integrated, to be understood internally. You only can get a big advantage from 3D-printing if the products have been designed for this technology.

It is really another way of thinking far from the constraints of traditional technologies, but it has its own constraints. As soon as this is achieved a budget, and a business plan can be set up for the implementation of 3D-printing with a big 3D-printer.

In Europe, we always have the impression that 3D-printing isn't ready yet, that we need more R & D projects. This is partly true. But let's look at what's going on in the USA and Asia: They are adopting this technology without any issues and finding the market for it.

Here in Europe, we are very traditional and most of ceramic manufacturers don't want to launch new technologies so as to avoid making their production machines outdated. This won't be the case as 3D-printing is not a substitution technology.

CA: *One aspect is that technical ceramic manufacturers want to make use of additive manufacturing to overcome limits set by other shaping technologies with regard to the complexity of component design. What advice can be given to assess additive manufacturing versus other technologies to achieve the best economic solution?*

RG: Again – additive manufacturing is not a technology in competition with traditional ones. It is another way to make parts, it is another way to design parts. As mentioned earlier, complexity is not a need but several integrated functions in a part is a must. In other words, redesign to 3D-printing is a must to get the benefit of this technology.

CA: *Can additive manufacturing lead us to new material solution – graded materials, multi-material/hybrid solutions?*

RG: Yes, definitely. On this matter, I invite everybody to visit 3DCeram by end of 2016 and those visitors will be amazed! 3DCeram will open up a new printing solution that was just sold to a partner in Spain.

Again, the future of 3D is secured if you can make in one shot a component design that still requires several stages at present. But in order to get the best out of it, you have to think out of the box! You have to stop thinking about what's already in your workshop but start thinking 3D!

CA: *What services can 3DCeram offer to enable their customers to get the benefit of 3D-printing or alternatively to develop customized products?*

RG: My partner Christophe Chaput comes from a technical centre where he worked for 20 years. He knows a lot about how to develop materials, which material is the best for which application. He is really one of the few experts in 3D-printed ceramic materials.

Thanks to his knowledge, we are able to develop paste and slurries on almost any system. This is one of the services that customers can expect to get from us: a printable material with their ceramic material. Another service where we feel we are strong is our ability to sell complete 3D-printing lines. These include the printer, the printable material, kilns and services. Services for us include a hotline to answer any questions about the process that customers may ask themselves and also training, aftersales services, etc.

This is what I did all my life with my former company Ceric: engineering of turnkey ceramics plants from the raw material preparation to packaging, including all process stages. 3DCeram is both: the best ceramic and engineering expert and this is what our customers like and what drives our success.

CA: *Thank you for talking to us.*

KS

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