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D6.3

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Ceramic component for medical technology

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Partners: (lead) RHP
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Project no. 633192

"Toolless Manufacturing of Complex Structures"

ToMax

FoF-02-2014 "Manufacturing processes for complex structures and geometries with efficient use of material"

D6.3 Provide first ceramic component for medical technology made from alumina

Due date of deliverable: 2016-04-01

Actual submission date: 2016-05-06

Start date of project: 2015-01-01

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Lead partner for this deliverable: RHP

Project founded by the European Commission within the Horizon 2020 Programme		
Dissemination Level		
PU	Public	X
CO	Confidential, only for members of the consortium (including the Commission Services)	

History chart

Version	Author	Date	Status	Reviewer
1.0	U.Werr	04.05.2016		
1.1	M.Schwentenwein	06.05.2016		T. Koch

Abstract

A generic design of a ceramic component that could be typically used in medical applications such as endoscopy surgeries was designed by RHP. It was built by Lithoz acc. to the 3D-file send by Rauschert.

The shape can only be made by 3D-printing, because it has a recess, which does not allow producing it by injection moulding.

Such a design may be able to replace the state of the art design, which is a coated metal part of similar shape. Due to the limited thickness of the coatings, the maximum electrical current, which can be used, is limited. The ceramic item with a thicker wall allows using higher electric tension, which is desired in some applications.

Inhalt

1. Introduction

The use of electrical tension to stop bleeding during surgeries is common use. To use this technique, the electric tension has to applied only in the area where needed. Therefore the instruments have to be electrically insulated.

A typical endoscopic instrument is a clamp, which can be closed when the electric tension is applied. The tip of the clamp, except the area, where the electric tension is applied, has to be totally insulated by a material that is able to achieve a medical approval. Such materials are alumina, zirconia, ZTA and may be in the future also silicon nitride (not mentioned in the standard for implant materials yet, but already rarely used in such applications).

2. Technical approach und Results

RHP did not manage to get a real design for an endoscopic instrument from one of their customers within the duration of the deliverable, therefore a generic design that shows all typical features in such applications was designed by RHP. A 3D-file was created and sent to Lithoz, to be printed from alumina. The following figures may illustrate the design of the item:

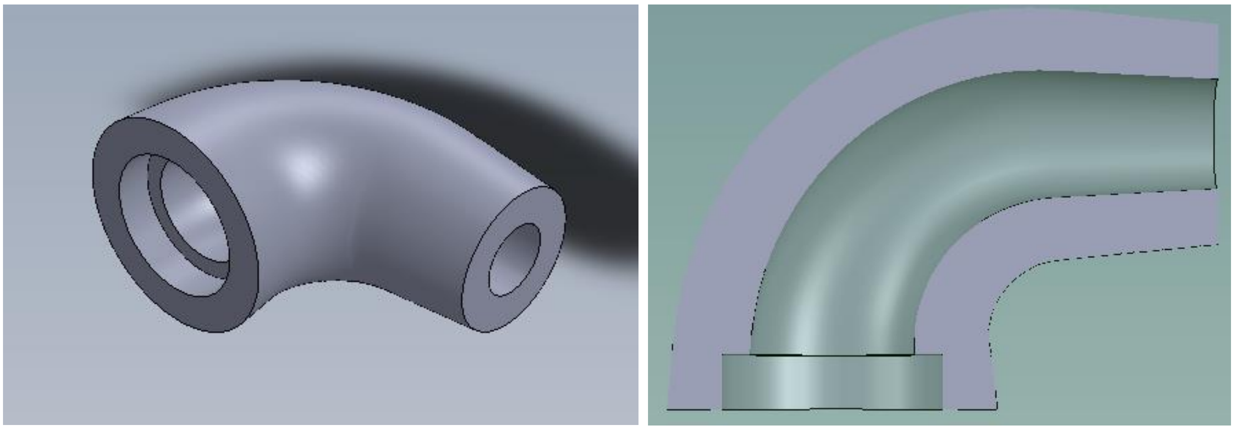

Figure 1: Isometric view (left) and cross section of the ceramic item

The drawing states the dimensions of the item shown:

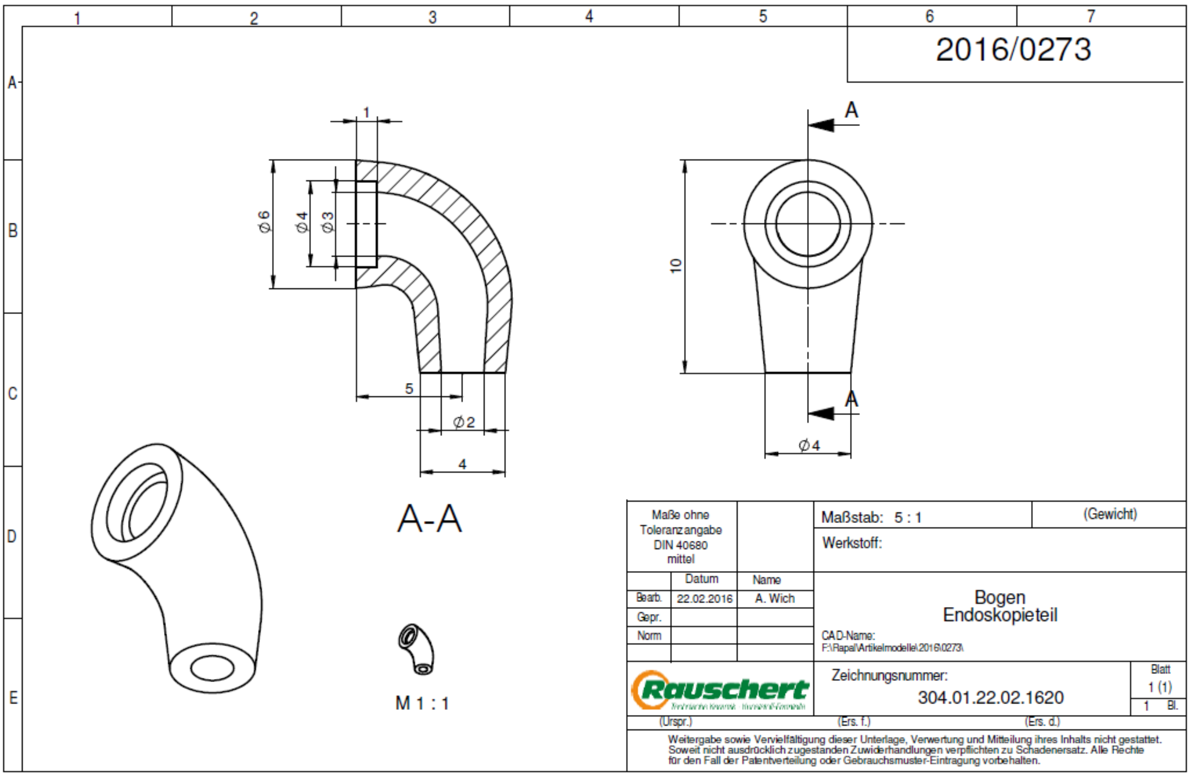

Figure 2: Technical drawing of the ceramic item for medical applications

The design was printed using the existing CeraFab 7500 setub from Lithoz as schematically depicted in Figure 3. The building envelope of the CeraFab-system is 76 x 43 x 150 mm. The resolution in the x/y-plane is 40 x 40 µm and the layer thickness was adjusted to 25 µm for this design. The corresponding building speed was 3 mm/hour in z-direction and 8 parts were printed in a single run.

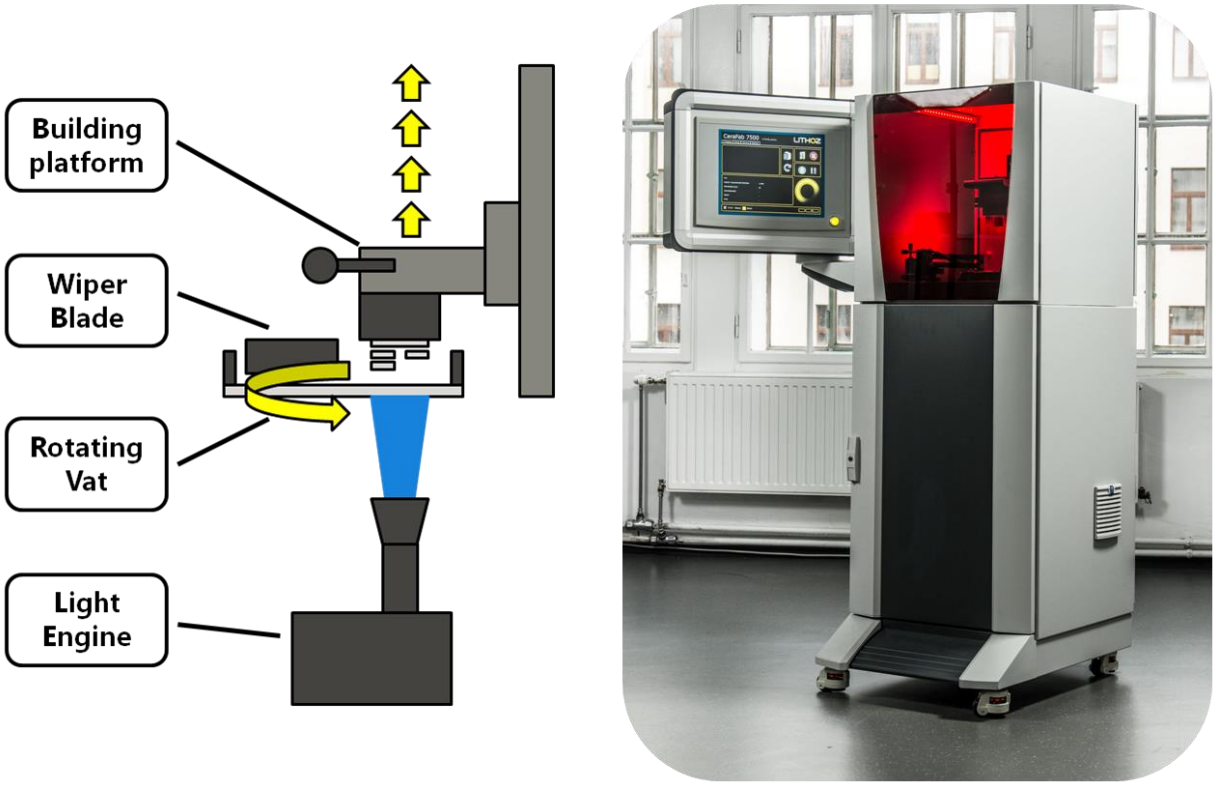

Figure 3: Schematic of the working principle of the CeraFab 7500 (left) and the actual printer (right)

The printing process itself relies on the principle of photopolymerization. First, the alumina powder was dispersed into a mixture of photocurable monomers to give the ceramic slurry (see D3.1). A thin layer of this slurry was automatically coated onto the vat, the building platform approaches the vat, only leaving a small gap of 25 µm which is filled with slurry, this gap corresponds to the thickness of an individual layer in the green part. The photosensitive compounds comprised within this slurry were then cured by selective exposure with light of a certain wavelength - where light hit the ceramic-filled slurry the monomers photopolymerized into a 3-dimensional network which then acted as a cage for the ceramic filler. After completing the layer, the building platform was elevated and the whole sequence was repeated all over again.

After the layer-by-layer structuring using the CeraFab 7500-system the green parts were cleaned from the excess slurry by immersing the part in an appropriate solvent capable of dissolving the slurry without damaging the cured structure.

The cleaned parts were debinded and presintered up to 800°C for a total duration of 92 h. Afterwards, the parts were sintered at 1600°C for 2h to give the final alumina ceramic. Using light microscopy no cracks or defects were detected in the manufactured parts.

The fired items (6 pieces) were send to RHP and analysed. The fired density was good (minimum required density is 3,92 g/cm³):

Table 1: Apparent density of fired items made of alumina

No.	Weight [g] dry	Weight [g] in water	app. Density [g/cm³]
1	0,5910	0,4416	3,946
2	0,5867	0,4375	3,920
3	0,5922	0,4416	3,921
4	0,5958	0,4442	3,921
5	0,5978	0,4459	3,926
6	0,5919	0,4415	3,935
		Mean:	**3,928**

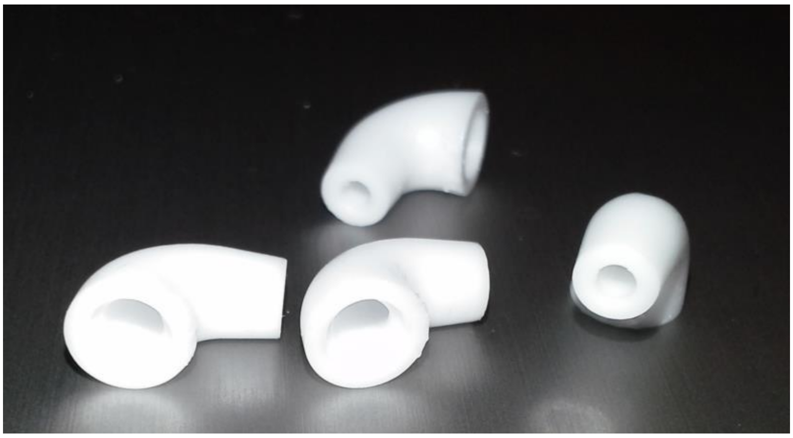

Figure 4: Fired items

3. Summary and future work

It was proven, that printed items are suitable to be used in applications such as medical instruments for endoscopic surgeries. The density is acceptable for such applications.

The new opportunities of AM allow new designs for ceramic items used in the medical field, because it allows producing shapes, which cannot be made by other manufacturing methods (including internal recess etc.).

RHP will proceed to look for new potential customers, who are interested to test AM for medical instruments. The Medtec 2016 exhibition in Stuttgart will be a good opportunity to get in touch with potential customers.