All under One Roof – Reconstruction of the CerAMfacturing Laboratories of Ceramic Components Completed

Fraunhofer IKTS/DE reports the completion of the reconstruction work of the CerAMfacturing Laboratories for Additive Manufacturing (AM) of ceramic, glass and hardmetal components. Since October 2020, the Working Group Shaping and Additive Manufacturing has been working in new and larger laboratories and can proudly present all devices for AM under one roof. At approx 200 m² the so far heterogeneously distributed AM technologies have been bundled and classified according to the kind of the initial material which is processed further by the different methods – either thermoplastic feedstocks, filaments, light-curable suspensions, or granulates for powder bed-based AM.

Fig. 1
Yellow-light zone for concentration of all devices using Digital Light Processing technology for layer-wise AM of ceramic parts

The lab area is now divided into separated zones adapted to the special needs of each AM method. One zone, the so-called Yellow Light Zone is completely closed up and equipped with yellow light sources for all of the machines working with light-curable suspensions for Digital Light Processing (DLP) techniques (Fig. 1).

Here, four devices for Vat Photopolymerization (CerAM VPP) – two CeraFab 7500 and one CeraFab 8500 (both Lithoz GmbH/AT) such as one Prusa SL1 (Prusa Research/CZ) – and one for DLP of light-curable polymers for making lost tool inserts for the so-called Free-form Injection Moulding – AFU5 (Addifab/DK) are placed. Related to this zone, a room for suspension preparation with climatically constant conditions has been established.

The CerAM VPP method is the AM technology with the highest possible resolution so far and allows to make components with tolerances <100 µm at present. Fraunhofer IKTS works with commercially available and develops own light-curable suspensions in a large variety for this AM route to build components of alumina, zirconia, ATZ, titania, silicon nitride, aluminium nitride, hydroxy apatite, and porcelain, but also of different glass powders. As an example, a lead containing glass has been processed by CerAM VPP for the development of an electrically conductive glass component for photomultiplier applications in a ZIM project (ZF4076432AG7) in collaboration with ProxiVision GmbH/DE.

A second zone (Fig. 2) is attributed to the thermoplastic CerAM technologies comprising at Fraunhofer IKTS Multi-Material Jetting (CerAM MMJ) and Fused Filament Fabrication (CerAM FFF). For the latter method two machines – 140L (HAGE/AT) and Prusa i3 MK3S (Prusa Research) are on-hand.

This process is by far the most cost-effective method for the production of single and multi-component parts for almost all sinterable materials. Advantageously, for preparation of feedstocks for filament extrusion the same equipment as known for Ceramic Injection Moulding can be used, i.e. powders and binder constituents are pre-mixed in SIGMA-kneaders, homogenized at either a twin-screw extruder KETSE 20/40D 1200 (Brabender GmbH/DE) or a

Fig. 2
Lab zone for thermoplastic AM techniques

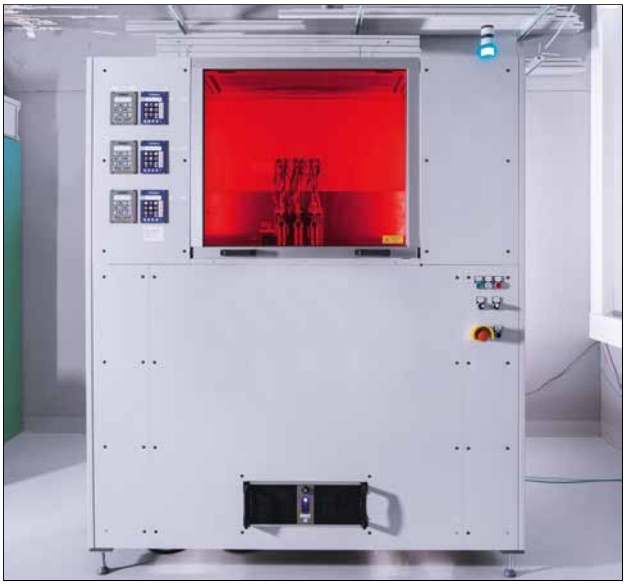

Fig. 3
Multi-material jetting device equipped with three microdispensing units, developed by Fraunhofer IKTS

shear roller BSW135-1000 (Bellaform GmbH/DE), and extruded into filaments by a single screw extruder KE30 (Brabender GmbH). Thus, material development can be made for both, CIM or CerAM tailored to the customer's needs.

The CerAM MMJ technology bases on micro-dispensing of droplets of a low viscous, wax containing thermoplastic feedstock. This CerAM method has been developed by Fraunhofer IKTS. It works material independent and has a unique selling point in the high-resolution AM of multi-material components, because up to four different materials can be deposited dot-wise, either together in one layer or in different layers. Indeed, Fraunhofer IKTS develops and constructs own devices for CerAM MMJ (Fig. 3). The minimal droplet size is approx 200 µm, the positioning accuracy is ≤20 µm, and the building space adds up to 200 mm × 200 mm × 180 mm. In the new CerAM lab, three CerAM MMJ machines can be represented, working with almost all kinds of technical ceramics including LTCC, further with porcelain, stainless steel, noble metals, hardmetals, cermets, and glasses.

In a third zone, the powder bed-based methods like Powder Bed Fusion (CerAM PBF) and Binder Jetting (CerAM BJT) are placed. At present two Z510 printers (Z-Corp./US) and one VX200 (Voxeljet GmbH/DE) are there in use for development of mainly porous ceramic structures for filtering elements, catalyst supports or bone replacement materials. However, also dense materials like hard metals or cermets can be built by CerAM BJT by means of liquid phase sintering. The properties of such components made by CerAM BJT are similar to those made by conventional hard metal shaping via pressing. The remaining gap in this room will be closed very soon by a CerAM PBF testing device which will be used in the frame of a nationally funded project.

For quality assurance of all components built via the above-mentioned AM technologies, a 3D-scanner (GOM/DE), an X-ray computed tomograph CT compact (ProCon X-Ray/DE) such as a profile scanner (Keyence/DE) are available. The latter can be implemented into the CerAM MMJ machines for measuring the dimensions and shape of each micro-droplet in real time.

As well-known for all powder-technological shaping routes, after the building process the components are still “green parts” which are not ready yet. For attaining final ceramic components, debindering and sintering steps are necessary. Fraunhofer IKTS is equipped with the corresponding technical devices for extraction and thermal debinding such as sintering furnaces including hot isostatic presses for all kinds of ceramics.

The CerAMfacturing Laboratories for AM of ceramic components offers development services and scientific support to customers who are already familiar with or beginners in CerAM technologies and who are interested in solving challenging innovative tasks in this exciting field of production.

All those interested are kindly invited to visit the CerAM Labs.

References

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