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Next generation multi-material 3D food printer concept

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Introduction

3D food printing is a new rapidly developing technology capable of creating food structures that are impossible to create with normal processing techniques. Interested parties are the food industry and culinary experts. A Michelin chef printed chocolate globes with a TNO developed food printer, see Figure 1.

Figure 1: Three chocolate globes filled with flavors originating from the highlighted continents printed by Michelin chef Wouter van Laarhoven.

Challenges

One of the challenges is the creation of different textures by printing regions with different structural properties. An example of the creation of different textures by printing denser or more porous layers is shown in Figure 2.

Figure 2: A multi-texture 3D printed food product from specifically designed cake mix created with powderbed printing and a post-processing baking step.

A second challenge is the creation of 3D food objects consisting of multiple materials. The materials should be depositable in a voxel like manner for complete design freedom. A first example of a multi-material food object created with concentric FDM is shown in Figure 3.

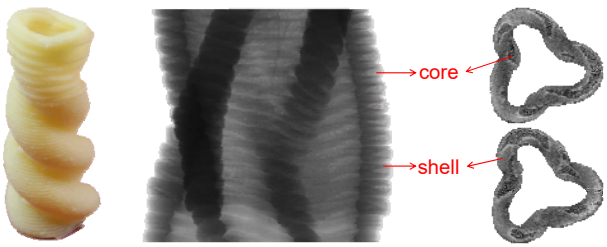

Figure 3: (Left) A printed fusilli pasta shape. (Right) Micro-CT images of the same shape printed with concentric FDM with two different materials, resulting in an outer shell and an inner core.

Next Generation Food Printer

To address these challenges a next generation food printer will be developed. This printer will be a powder bed printer capable of creating a multi-material powder bed. Powder deposition will be akin to the rain model[1], shown in Fig 4.

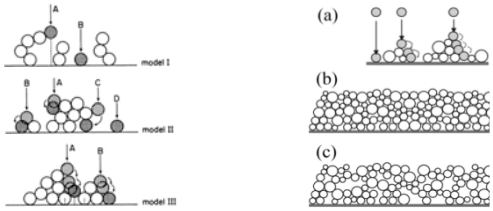

Figure 4: (Left) Three types of rain models with (I) no- (II) partial- and (III) multiple-restructuring. (Right) A 2D simulated powder bed based on model III with relative 3D density by particle removal[2].

For the creation of multi-material powder voxels a miniaturized piezoelectric activated micro hopper is envisioned. Intermittent deposition of different powder types is possible with this device[3] by actively breaking the powder dome structure formed in a nozzle creating a flow. The forming of a powder dome is shown in Figure 5.

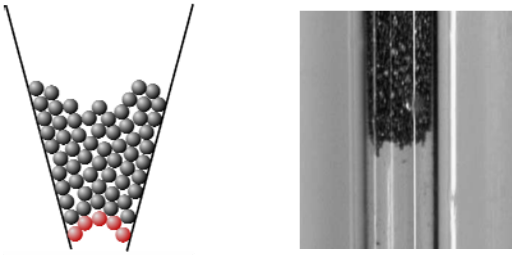

Figure 5: (Left) A schematic representation of a powder dome of granular material in a nozzle. (Right) A powder dome of tungsten carbide in a 210 µm inner diameter tube[4].

Conclusion and future work

All sub-processes for creating multi-material, multi-texture 3D printed food objects are available. Combining these processes in a single machine is simple engineering. Future work will entail the creation of a 3D Discrete Element Method model to simulate powder flow through a hopper and subsequent powder bed generation.

References

[1] Meakin, et. al, Jour. de Phys., 1987. [2] Körner, et. al., Model. Simul. Mater. Sci. 2013.
[3] Chianrabutra, et. al. , Proc. Solid FF., 2014. [4] Yang, et. al. , Powder Tech., 2004.