Experimental characterization and modeling of the mechanical behavior of Selective Laser Sintered food

N. Jonkers*, **J.A.W. van Dommelen and M.G.D. Geers**

Department of Mechanical Engineering
Eindhoven University of Technology
Groene Loper 3, 5612 AE Eindhoven, The Netherlands
e-mail: n.jonkers@tue.nl

ABSTRACT

The consumption of food is subjective and personal. For personalisation and for health applications, there is a need for food customization. The possibility of additive manufacturing techniques to tailor product properties make them interesting to use as a food processing method. Currently, the most used technique is based on extrusion, but the self-supporting characteristic of Selective Laser Sintering is more suitable for complex structures. To make use of the power of AM to design or optimize food with specific properties, a modeling approach is very beneficial. To model complex food systems, the mechanical behavior of the printed material has to be characterized and understood. This mechanical behavior is a result of the microstructure that results from a combination of process conditions and the used ingredients.

In food engineering, the Texture Profile Analysis (TPA) test [1] is often used which gives insight in mechanical properties of food but the interpretation of the results can be ambiguous. The reason for this is that properties are extracted from a force-displacement curve in which the probe and sample have a non-standardized geometry. The characteristic quantities obtained from the test are not intrinsic material properties. Moreover, only a limited amount of researchers has been aiming for constitutive modeling of food. These models do not consider plasticity and do not have the possibility to describe brittle failure.

This contribution is focussing on proper characterization and modeling of the Selective Laser Sintered food in terms of the intrinsic material behavior, which is essential for product customization. To predict product properties at the scale of the printed geometry, shown in Figure 1, the focus is on modeling the response at the scale of the effectively homogeneous printed material. The effective properties originate from the microstructure which is controllable by the laser sintering process. The characterization is based on compression testing of printed cilinders with dimensions of a few millimeters. An elasto-viscoplastic framework is formulated including a damage law to describe the brittleness of the material. A finite element implementation allows for studying the effect of sample roughness on the obtained stress-strain relation to identify all model parameters.

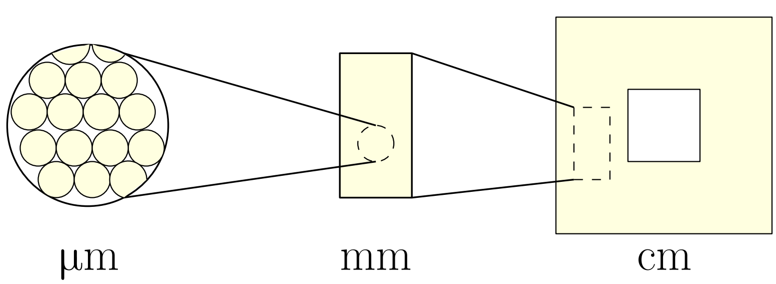

Figure 1: Multiscale characteristics of additive manufacturing of food.

REFERENCES

[1] Friedman, H.H., Whitney, J.E., Szczesniak, A.S. The texturometer - a new instrument for objective texture measurements. *Journal of Food Science* (1963) **28**:390–396.