CREATION OF A GELATIN BASED EDIBLE FILAMENT FOR USE IN FUSED DEPOSITION MODELLING

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INTRODUCTION

Fused deposition modelling (FDM) is a type of additive manufacturing which uses filament with an extrusion technique to create an object layer-by-layer. The object to be printed is uploaded to a computer programme called 'Cura', which slices the object into layers and creates a geometric path for the extruder to follow (Oropallo and Piegl, 2015). The filament is pushed through the extruder nozzle, where it is heated and then extruded onto the plate following the predetermined path to create the object. Figure 1 shows an image of a FDM printer.

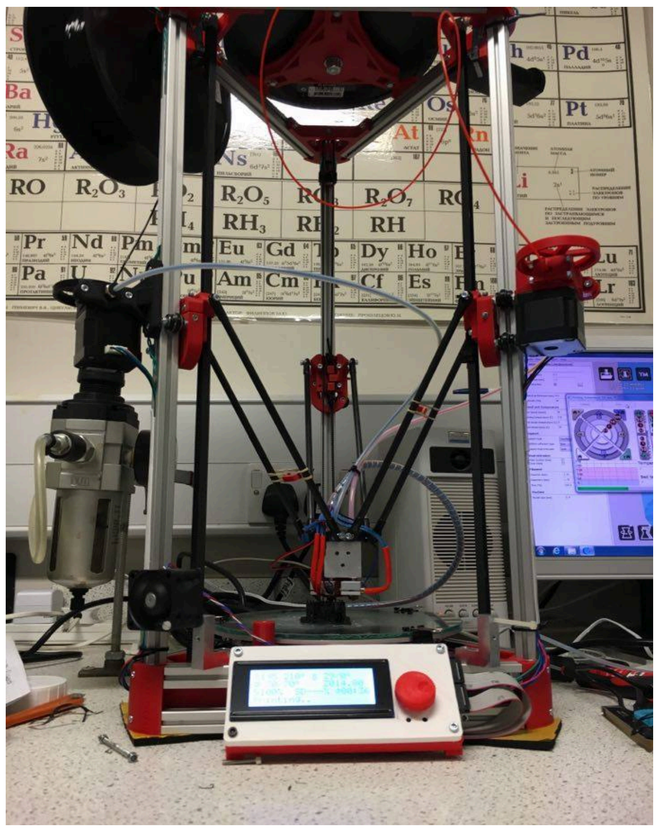

Figure 1- FDM Printer

The use of additive manufacturing allows versatility, and the ability to produce novel structures is thought to lead to methods of producing and reproducing microstructure in edible substances. The consumer will have the ability to customise their food in order to get a personalised experience in anything from flavour to nutrition.

The filament to be printed needs to be thermoreversible. When it enters the extruder, the filament needs to be solid and become liquid as it is heated when it goes through, so that is can be moulded into the correct pattern. Once it has been extruded it needs to quickly cool down to a solid, so that the object can be built. This study aims to characterise gelatin under the relevant conditions to identify its suitability as a printing filament.

MATERIALS AND METHODS

A 30% concentration of gelatin gel was created by mixing gelatin pellets with water under an agitated and heated environment.

The gelatin was tested in a MicroDSC using a temperature range from 5-90℃ and cycled through these temperatures 3 times. The thermograms for this can be seen in Figures 2 and 3.

The gelatin underwent a viscosity test at a constant shear of $25s^{-1}$ and a frequency test at constant stress. Both of these tests were conducted at a starting temperature of 60℃ and finished at a temperature of 10℃. The results of these can be seen in Figures 4 and 5.

RESULTS

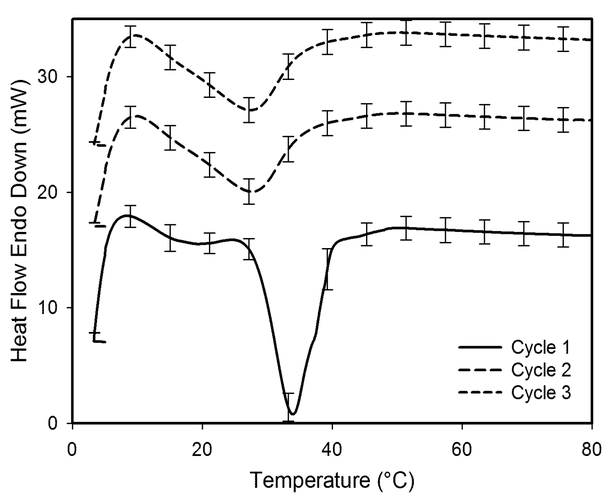

Figure 2- MicroDSC Thermograms of Heating Cycle

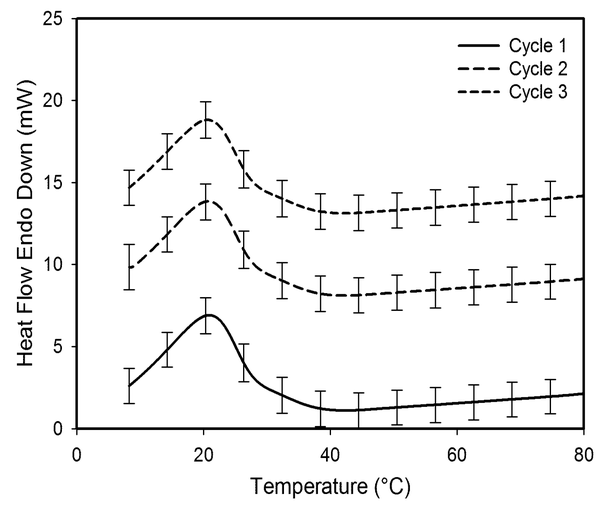

Figure 3- MicroDSC Thermograms of Cooling Cycle

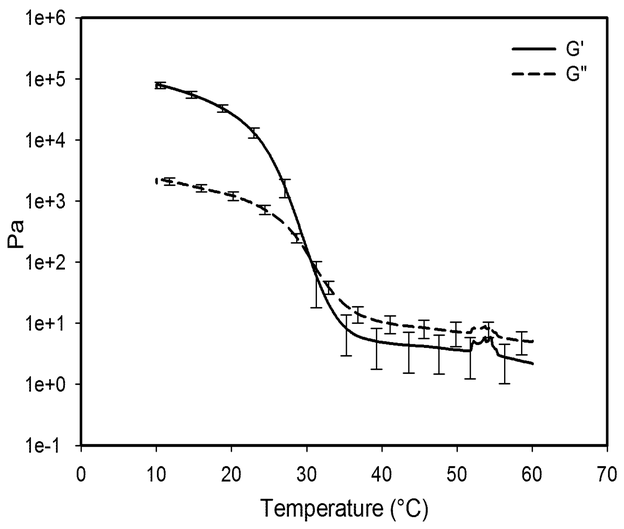

Figure 4- Viscosity behaviour as a function of time (log scale)

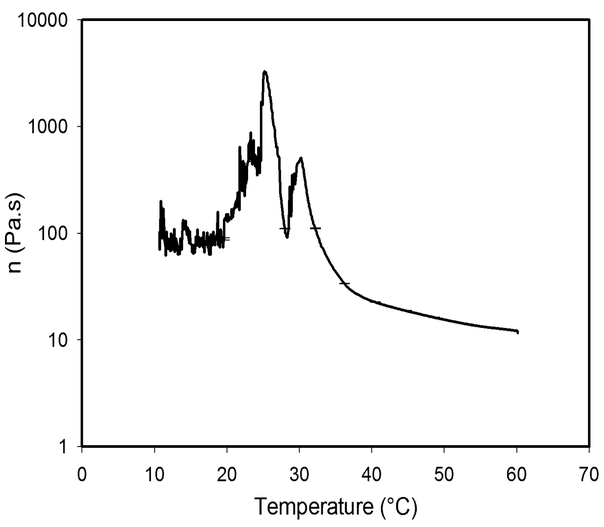

Figure 5- Frequency behaviour as a function of time (log scale)

CONCLUSION AND FURTHER WORK

The MicroDSC thermograms are different between the first cycle and cycles two and three. It is likely that the first peak is due to long triple helixes which initially had time to form in the gelatin during its production, however when it is heated these break up and do not have time to reform before the next cycle. This finding indicates that the final printed gelatin product properties would be strongly dependent on temperature profiles during printing.

All the results indicate that the gelatin solidifies around 35℃, so the extruder would need to be able to sustain this temperature while it is printing in order to make gelatin filament viable.

Comparing the properties of gelatin to filaments that are currently used in additive manufacturing, such as Polylactic acid (PLA) and Acrylonitrile butadiene styrene (ABS), in order to develop design rules for future formulations.

Characterise the extrusion process, so the process can be mimicked within the DSC to obtain how it will affect the gelatin.

REFERENCES

OROPALLO, W. & PIEGL, L. A. 2015. Ten challenges in 3D printing. *Engineering with Computers,* 32**,** 135-148.

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