Study and development of a 3D printing solution for the manufacturing of medicines

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Diplôme : Master en ingénieur civil mécanicien, à finalité spécialisée en génie mécanique
Année académique : 2017-2018
URI/URL : http://hdl.handle.net/2268.2/4602

Study and development of a 3D printing solution for the manufacturing of medicines

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ACADEMIC YEAR 2017–2018

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This master thesis focuses on the realisation of medicines with complex geometries by 3D printing. In medicines, the distinction should be made between actives principles and excipients. These latter are inert substances that give texture, taste and also stabilise the active principles. This work focuses on shaping these excipients that are basically polymers.

Different 3D printing technologies are available but among them, Fused Deposition Modelling (FDM) is chosen. This technology has the particularity to work with filaments. The problematic faced in the project is that the pharmaceutical polymers are very difficult or even impossible to use with a FDM printer. It is thus necessary to adapt the 3D printer, and more precisely the extrusion head, to these materials and this is the subject covered by this work.

In order to become familiar with the domain, the scientific literature concerning medicines 3D printing was first explored. After having gathered useful informations about the 3D printing of medicines, different technical solutions were envisaged. One of them was then developed. This solution consists basically in a mini-extruder, with an extrusion screw inserted into a barrel such as commercial extruders but far more compact, about 15 cm. The advantage of this system is that it works with powder or pellets. This gets around the impossibility of printing the pharmaceutical polymers encountered by the classical printers. Concerning the reasoning behind the new extrusion head, the difficulties hide in the fact that this concept was never mentioned in literature. The design is thus based on complete thermal, mechanical and polymer flow studies and computations. Once the design was completed, the first prototype was fabricated. A particularity of this prototype is that it was entirely fabricated by 3D printing.

Concerning the results, experimental extrusion tests were carried on the new extrusion head fixed separately from the 3D printer. The regularity of the output filaments was assessed and the variability of the throughput was also measured. The results were satisfying for the reference pharmaceutical polymer and very close to the theoretical ones. The head could thus be integrated on the 3D printer. The mechanical integration is successful and it remains thus to modify the firmware of the machine in order to integrate fully the new extrusion head. After that, real 3D printing tests could be carried out.

In conclusion, based on a concept found in the literature, a solution was found for the 3D printing of medicines. This solution was experimentally tested with pharmaceutical polymers and its performances were evaluated. It remains only to verify that the system operates correctly during real 3D printing tests.

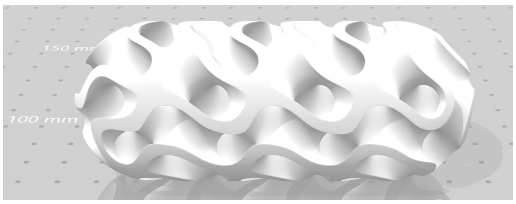

Figure 1: Particular geometry envisaged for a tablet.

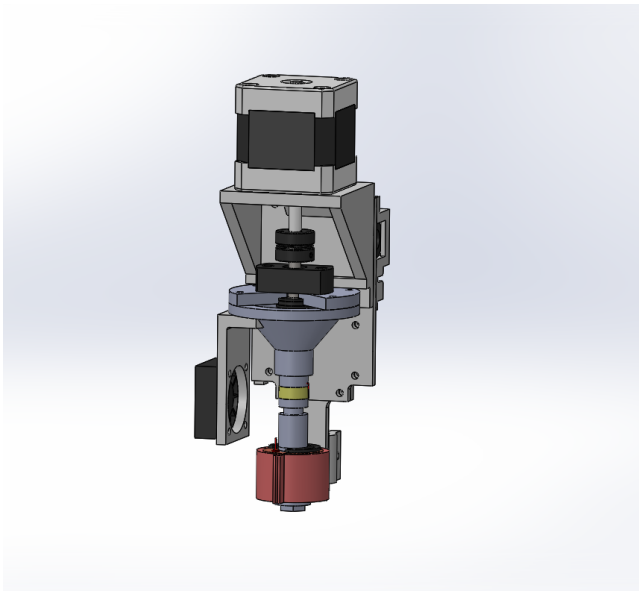

Figure 2: CAD design of the new extrusion head.

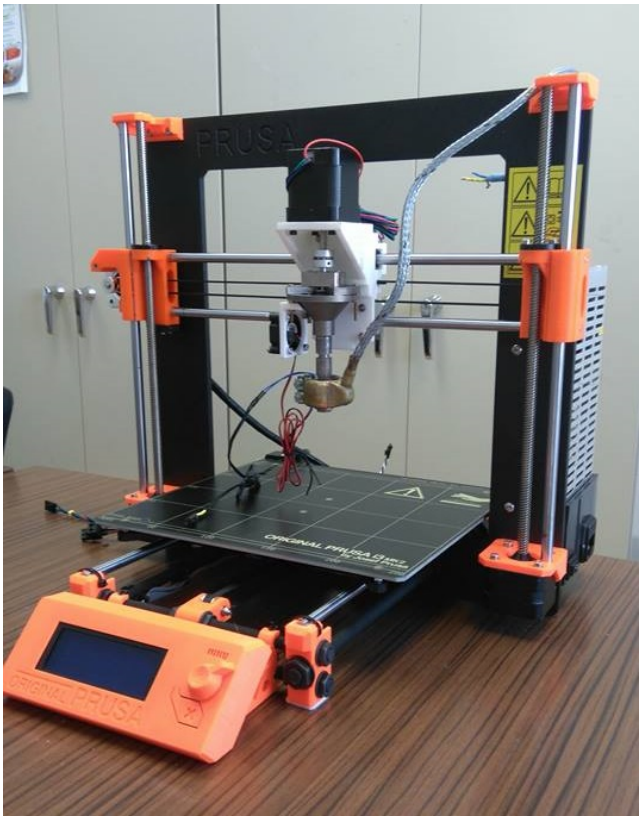

Figure 3: Integration of the new extrusion head on the 3D printer.