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Investigation of the mechanical properties of hot-melt extruded filaments for pharmaceutical applications of FDM

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The advent of additive manufacturing techniques, namely Fused Deposition Modeling (FDM), holds many promising prospects for medical applications, from tailored polypills for personalized medicine to patient-specific implants. However, the lack of pharmaceutically-acceptable materials that possess suitable properties for FDM is the main issue standing in the way of turning FDM into a commercially viable process. And although a number of research efforts has demonstrated the feasibility of using blends of pharmaceutically relevant polymers to print pharmaceutical dosage forms, there remains little-to-no investigation into the critical parameters that govern the feasibility of an FDM process. Mechanical properties of the filament used in FDM is one such critical parameter; part of the filament feeding process involves rotating gears pushing the filament into a pinhole slit that leads on to the heating element of the printer. Trial and error attempts at feeding various in-house prepared filaments to the printer revealed that filaments need to possess specific mechanical properties; filaments which are too brittle will fracture inside the print head causing a blockage, filaments which are too deformable will coil around the conveyer gears without threading into the melting zone. This presentation outlines an in-house developed method to identify the desired mechanical properties for FDM filament: A TA.XT 2 Texture Analyzer fitted with an in-house prepared rig loosely based on the spaghetti flexure rig was used to quantify forces required to deform a number of commercial and in-house filaments. Principal Component Analysis (PCA) was used to sort the data collected from the texture analysis and categorize the various filaments into feedable and non-feedable. The method was then employed to evaluate the feedability of an ibuprofen formulation to verify its suitability as a method to test the mechanical properties of filaments.

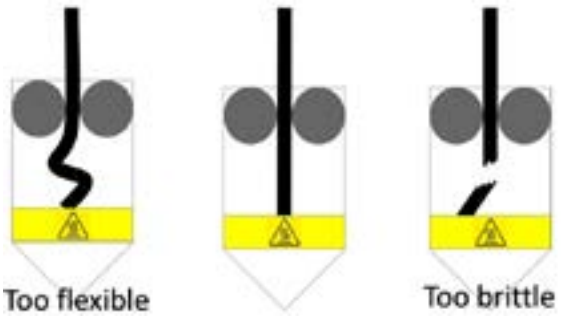

Figure 1: *Different types of mechanical properties and their effect on ability to feed a filament into the printer.*

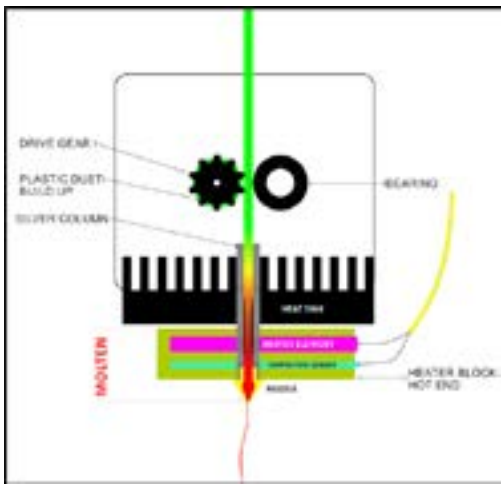

Figure 2: *Internal anatomy of an FDM 3D printer, demonstrating filament threading.*

Biography

Jehad Nasereddin completed his BSc in Pharmacy from the University of Petra, Amman, Jordan in 2015. He pursued Master of Science in Pharmaceutical Technology Program at the University of Bradford, UK in 2016. In April 2017, he started his PhD at the University of East Anglia, under the supervision of Dr. Sheng Qi. His project focuses on investigating the process parameters involved in Fused Deposition Modeling. His research interest includes: hot melt extrusion, amorphous pharmaceutical solids, fused deposition modeling,pharmaceutical dosage forms and thermoplastic polymers.

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