Personalized therapies tailored to the patients' physiological and pathophysiological conditions could effectively improve quality of life and reduce the risk of side effects. The paradigm of personalized medicine may become available via application of additive manufacturing (AM), commonly known as 3D printing. Low costs, small-scale manufacturing as well as shape, dose, and drug release profile customization make AM an attractive approach for drug delivery systems personalization. **Due to its low cost, high print quality, wide availability, and low cost of maintenance, Fused Deposition Modelling (FDM) has become one of the most popular 3D printing methods**.

Currently one of the biggest challenges for a broader use of FDM technology in pharmaceutical 3D printing is the lack of commercially available filaments (polymeric materials) that are made of pharmaceutical quality materials.

Method for fabrication of APIs (Active Pharmaceutical Ingredient) incorporated filaments is hot melt extrusion (HME). In this process raw materials (e.g., drug, polymer, and plasticizer) are blended and mixed in the extruder barrel with the aid of a single or twin-screw system under controlled temperature and pressure to form homogenous mixtures that can be extruded into granules or mold into shapes (e.g. filaments) through a nozzle.

Combined application of HME and FDM enables to obtain a homogenously mixed drug/polymer blend in the form of filaments that can be used to print variety of complex drug forms in a personalized way using a continuous manufacturing process. In this approach the drug dose in the final form can be designed at the early stage of drug product development (e.g. at the stage of filament fabrication) and flexibly scaled by changing the shape and/or size of the dosage form. Furthermore, filaments made of polymers with distinct drug release profiles enable to control the release of an API from a final dosage form.

A major limitation to the large-scale use of FDM in the pharmaceutical industry is the lack of studies on the miscibility of the drug with polymers and plasticizers and the effect of the drug phase (amorphous/crystalline) on mechanical properties of filaments.

The proposed project aims to understand how drug/polymer/plasticizer miscibility affects the mechanical properties of the filaments and their processability with Material Extrusion printers.

The project aims to answer the following questions: (i) Is design and control of elastic properties of extruded filaments based on knowledge of the miscibility and local interactions within the drug/polymer/plasticizer blends? **(ii)** How do interactions between the formulation components affect miscibility? **(iii)** What effects does the drug form (amorphous/crystalline) have on the mechanical properties of the extruded filament?

This will be achieved via a systematic investigation of the interactions within drug/polymer/plasticizer systems composed of pharmaceutically relevant polymers widely used in materials extrusion, model drugs differing in structure, melting temperature, and their glass forming ability as well as plasticizers selected for polymer based systems. The evaluation of the drug phase in the extrudates (crystalline or amorphous), local interactions between constituents, changes in glass transition temperature of the blends and elastic properties of the filaments should enable us to gain molecular level understanding of the effect of drug/polymer/plasticizer interactions on macroscopic properties of the obtained materials. **This knowledge is critical for rational design of novel polymer blends that can be used in additive manufacturing of personalised medicines using materials extrusion technologies.**

Experimental and theoretical techniques will be used to determine miscibility and local interactions in drug/polymer/plasticizer blends that affect the mechanical properties of drug loaded filaments that can be used in additive manufacturing of personalized medicines via materials extrusion techniques. The methods that have previously been used to determine drug/polymer and polymer/polymer miscibility in amorphous solid dispersions will be used here for the first time to understand the effect of miscibility on the mechanical properties of the extruded filaments **- a critical parameter enabling successful use of drug loaded filaments in 3DP using the FDM method.**

The final result will evaluate the safe limit of drug incorporation into the formulations based on the miscibility of drug-polymer-plasticizer systems and determine the critical parameters affecting the mechanical properties of the obtained materials.