UNIVERSITÀ DEGLI STUDI DI SALERNO

Facoltà di Ingegneria
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Corso di Laurea in Ingegneria Chimica

Modeling the drug release from HPMC tablets with different macrostructure

Master thesis in:

Transport Phenomena

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Part of this work has been performed in partnership with the Chalmers University of Technology in Goteborg, under the supervision of Prof. Anette Larsson.

To my mam and dad

Questo testo è stato stampato in proprio, in (font adoperato)

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Table of contents

List of figures

List of tables

Abstract

Using 3D printing, it is possible to design and develop complex dosage forms that can be suitable for tuning drug release. It, indeed, allows a flexible variation of the drug dose, release characteristics, or implementation of combinations of several drugs in the same dosage form to correspond to the individual patient needs. Polymers are the key materials that are necessary for 3D printing and it is important to understand which polymers are suitable for extrusion-based 3D printing of pharmaceuticals.

With 3D printer disc with different infill, disc with different pattern of infill and disc with different macrostructure can be printed. Discs with different macrostructure have been studied in order to analyze how different macrostructure impact on the drug release.

When a network of long polymers is immersed in a physiological fluid, this starts to penetrate inside the polymeric hydrophilic matrix. When a certain solvent concentration is reached, the polymeric chains unfold due to a glass-rubber transition, and a gel layer is formed. In the swollen region, the drug molecules can diffuse toward the dissolution medium, once they are dissolved.

In order to consider the hydrogel mechanics, the pure hydrogel behavior has been studied. Hydrogels normally couple solvent mass transport to system deformation and vice versa. This phenomenon is generally called poroelasticity and it is characteristic also of other materials. This complex behavior, generally defined “poroviscoelastic”, is the sum of a poroelastic and a viscoelastic behavior. The first is due to long-range motion of the water molecules, which can enter (swelling) or leave (shrinking) the system or move within the system (isochoric deformation). The viscoelasticity, instead, is mainly a characteristic of the polymeric structure, which can rearrange its spatial configuration (i.e. by the breakage and reformation of cross-links) and respond with

a time dependent mechanical behavior. The full understanding of this behavior is crucial to correctly design such complex systems.

The aim of this thesis is to simulate thought poroelastic modeling, the drug release from tablets of HPMC hydrogel with different macrostructures that will be printed using 3D printer. In this thesis, the monophasic approach, which is more consistent, has been chosen. This model considered hydrogel as single-phase matter, in which several components can coexist and therefore the properties are not of the single phase but of the combination of all the species.

The simulation has been done with the software COMSOL Multiphysics 5.2. This software is able to resolve the Partial Different Equations (PDEs) that describe the system, through the Finite Element Method (FEM). The work can be divided in two parts. In the first part the mathematical models of the tablet with different macrostructure have been studied and implemented in the software, at this point the sweep parametric has been executed in order to understand how the parameters impact system.

In the second part, since different models have been studied, the comparison between them has been done in order to understand how the macrostructure impacted the system.

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Eventuali ringraziamenti (su pagina dispari)

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