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The development of computer aided tools for the formulation design of FDM 3D printed polypills

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FDM (Fused deposition modeling) 3D printing has received increasing interests in being used as a fabicration method for producing polypills. Computer aided formulation designed to acheive desireable drug release rate will allow rapid product development, but require a fuller understanding on how to use the matrices to control the release rate. Polymers used in FDM 3D printing as carriers for oral dosages affect the release profile due to their intrinsic properties. Three such properties that may occur concurrently are hydration, swelling and erosion characteristics. Currently, there is no model or database that encompasses these three characteristics for majority of the pharmaceutical polymer used in the *in vitro* studies This study constructs a database that entails these 3 aspects using 7 model pharmaceutical polymers. Further, the effect of generic drug types and blend miscibility were investigated. Gravemetric and dimensional measurements were perfomed and process parameters were calculated as ratios and percentages of intial conditions. Combinational approach of these 2 methodology helped distinguish swelling, hydration, and erosion. These parameters along with other polymer descriptors are incorporated in the database. In addition, simulations aided in validation and prediction of these 3 processes. Hydration can be estimated via the Peleg equation, erosion via a modified version of Erlang equation and swelling via a modified equation presented by Peppas-Moynihan. The modelled data has been extended to incorporate drugs and miscibility blends to validate the effect of the 3 processes. The model can be used as a guidance for factors influencing release rate variability of 3D printed dosages and aid an user in acheiving a desired release profile via choosing polymer/polymer blends of appropriate combination in the manufacture of polypills. Shown below is a depiction of polymer diffusion for PVA at initial setup and after the passing of some time.
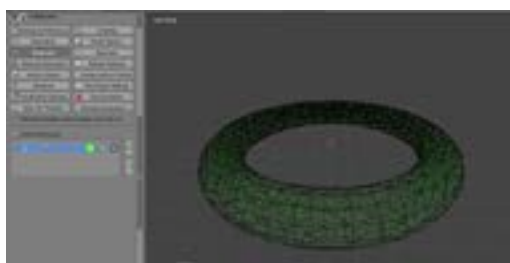

Figure 1: *Simulation interface at start of simulation depicting tablet and polymer particles at initial time*
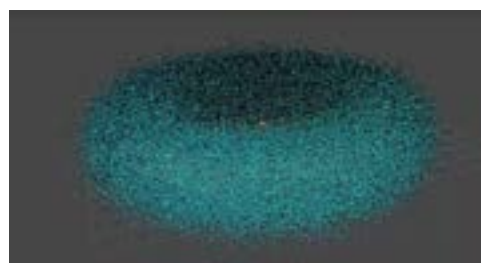

Figure 2: *Particle dispersion at a chosen time interval. Drug and polymer particles can both be visualized in this manner.*

Recent Publications

1. Burkersroda F V, Schedl L, Göpferich A (2002) Why degradable polymers undergo surface erosion or bulk erosion. Biomaterials.23(21):4221-31.

2. Davidson G W R, Peppas N A (1986) Solute and penetrant diffusion in swellable polymers: VI. The Deborah and swelling interface numbers as indicators of the order of biomolecular release. Journal of Controlled Release. 3(1):259-271.

Biography

Salman Rahman has completed his MS in Applied Mathematics from University of Washington, Seattle, Washington, USA. He is currently pursuing PhD in the Department of Pharmacy, University of East Anglia, UK focusing on drug design of FDM 3D printed polypills.

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