ARISTOTLE UNIVERSITY OF THESSALONIKI
RESEARCH COMMITTEE

3D PRINTING OF ELABORATE PHARMACEUTICAL FORMULATIONS FOR PERSONALISED THERAPY

Demonstration of the applicability of 3D printing
to pharmaceutical oral formulations' manufacturing,
by creating pharmaceutical dosage forms
that exhibit zero-order release properties,
are specifically designed to release
the active pharmaceutical ingredients (API's)
at desired pH values or incorporate more than one API's
with different dosage regiments
for combined pharmacotherapy.
Convenient personalization of the formulations,
speed of manufacturing and limited manufacturing
procedure stages highlights
the perspectives of 3D printing
as a future alternative method of drug manufacturing.

Application Field
Pharmaceutical Technology
Personalized Medicine

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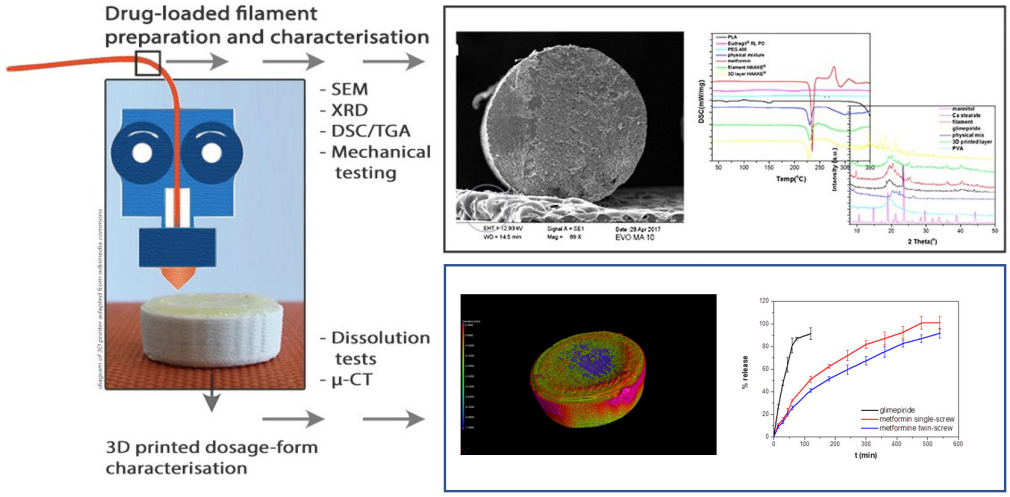


Figure 1 General principles of filament formulation, 3D printing procedure and physicochemical tests performed to evaluate the feasibility of the printing procedure and the quality of 3D printed dosage forms.

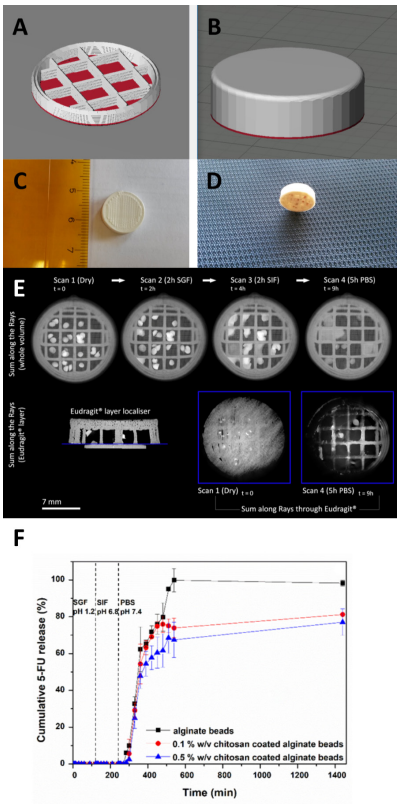
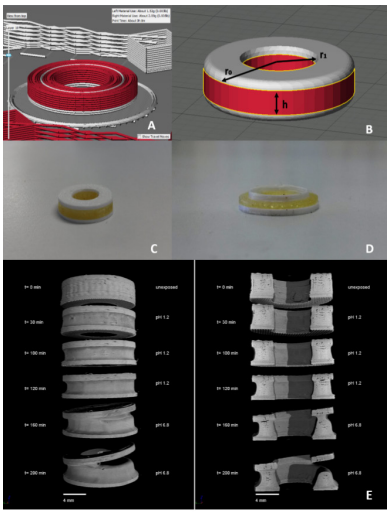


Figure 2 Controlled Release of 5-Fluorouracil from Alginate Beads Encapsulated in 3D Printed pH-Responsive Solid Dosage Forms. Stereolithography (.stl) images of **A**. inner and **B**. outer structure of the dosage form. **C**. Top and **D**. bottom images of the 3D printed dosage form. **E**. Time-lapsed X-ray microfocus computed tomography (µCT). Top row: Sum along the Rays renderings of the printed dosage form at its initial/dry state (scan 1), after 2-h exposure to SGF (scan 2), consequent 2-h exposure to SIF (scan 3), followed by 5-h exposure to PBS (scan 4). Bottom row: Sum along the Rays renderings through the Eudragit®-based layer only, before and after the 9-h exposure of the pill to the various solutions. **F**. Cumulative (%) 5-FU release from the 3D printed dosage form containing the non-coated and chitosan-coated alginate beads. [Gioumouxouzis et al., Controlled Release of 5-Fluorouracil from Alginate Beads Encapsulated in 3D Printed pH-Responsive Solid Dosage Forms. AAPS PharmSciTech (2018)].



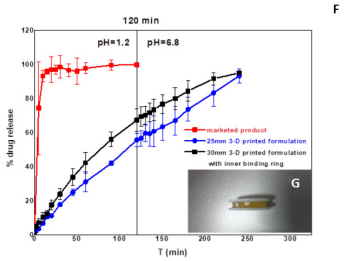
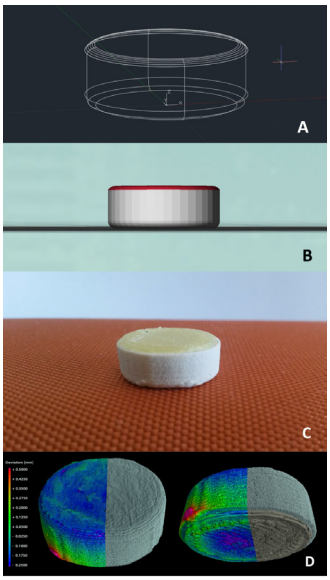


Figure 3 3D printed oral solid dosage forms containing hydrochlorothiazide for controlled drug delivery. **A**. Stereolithography (.stl) model of 3D PVA-PLA three-compartment hollow cylinder formulation with inner binding PLA ring. **B**. Design depicting characteristic dimensions (h, rO, r1) of 3D PVA-PLA formulations. **C**. Images of 3D printed and **D**. half-constructed 3D printed three-compartment PVA-PLA dosage form with inner binding PLA ring. **E**. µCT time-resolved 3D (volume) renderings of the 3D printed dosage form (0.25 mm height) during simulation of dissolution process (whole printed dosage form and middle vertical cross-section). **F**. Dissolution curves of marketed HCTZ product, 3D printed formulation with inner PVA layer with 0.25 mm height, 3D printed formulation with inner PVA layer with 0.30 mm height and inner PLA binding ring, (**G**. Inset) eroded 3D printed dosage form removed from dissolution medium at 120 min. [Gioumouxouzis et al., 3D printed oral solid dosage forms containing hydrochlorothiazide for controlled drug delivery. Journal of Drug Delivery Science and Technology, (2017), 40, 164-171.].



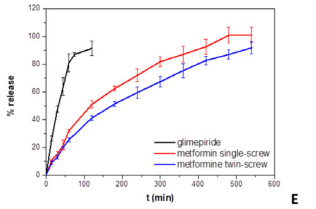


Figure 4 A 3D printed bilayer oral solid dosage form combining metformin for prolonged and glimepiride for immediate drug delivery. **A**. Autocad® draw, **B**. stereolithography (.stl) model and **C**. image of the 3D printed formulation. **D**. Combined µCT and deviation map volume renderings showing the deviation from the CAD design. **E**. Dissolution curves of the API's from their 3D printed formulations (PVA matrix for glimepiride and Eudragit® RL matrix for metformin). [Gioumouxouzis et al, A 3D printed bilayer oral solid dosage form combining metformin for prolonged and glimepiride for immediate drug delivery. Eur J Pharm Sci, (2018), 120, 40-52]

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