POSTER 68

CMAC FUTURE MANUFACTURING RESEARCH HUB

A STORY OF A 3D PRINTING FILAMENT

From a single component to a pharmaceutical 3D printing Filament

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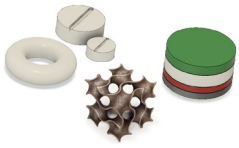
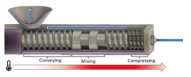
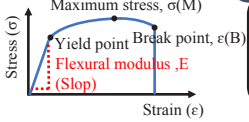
Motivations

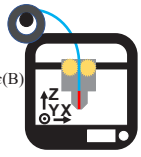
NEW Potentials [1]



Challenges [2]

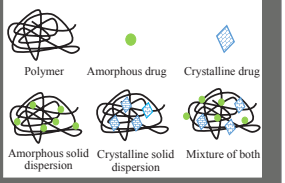






Hot melt extrusion | Mechanical properties | 3D Printing

Filament / ink [3]



How did we do it?

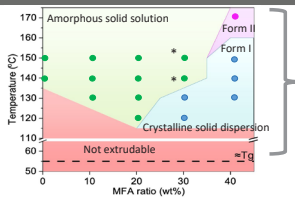
1. Binary system
Drug-Polymer
Mefenamic acid - Eudragit EPO
MFA - EPO
→ Phase diagram

2. Multicomponent systems
Drug-Polymer-Plasticizer-Filler
→ A) Plasticizer Screening | Molecular interaction | B) Filler Screening

3. Ratio optimisation
Design of Experiment (DoE)
3D printing test => Limits
ε(B), E/η, σ(M)
(wt%)
MFA (10-20%)
Stearic acid (StA)(5-10%)
Silica (10-30%)
Prediction
Printable?

What did we achieve?

1



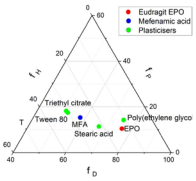
Phase diagram of EPO:MFA (Xray diffraction, ±5%wt).
* presence of crystalline Raman Microscope

Mechanical properties: Good | Acceptable | Bad
All MFA-EPO binary formulae
Brittle and not feedable into the printer

2

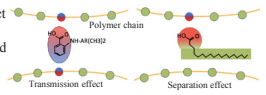
A) Plasticizers:

Teas plot of the Hansen solubility parameters (HSPs) for polymer, drug and plasticizers



EPO-Plasticizer (5%)
MFA(20%)-EPO-StA
MFA(20%)-EPO-Other plasticizers

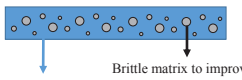
Plasticization effect MFA-EPO (Transmission) and EPO-StA (Separation)



MFA ↑ brittleness
TEC and TWN ↓ MFA solubility
StA ↑ flexibility
Yet not printable

B) Fillers: Talc 45um, Talc 75um, Silk powder or Silica

Improving mechanical properties of the plasticized formula



EPO-StA-Any Filler (20%)
MFA(20%)-EPO-StA-Silica
Break and buckle in the 3D printer

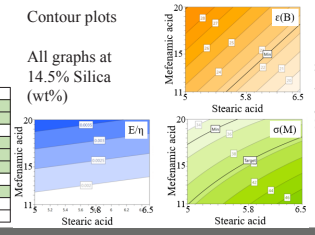
3

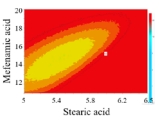
3DP test

T at Extrudable	150°C
DoE1	Yes
DoE2	Yes
DoE3	No
DoE4	Yes
DoE5	Yes
DoE6	Yes
DoE7	No
DoE8	Yes
DoE9	No
DoE10	No

Contour plots

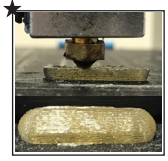
All graphs at 14.5% Silica (wt%)





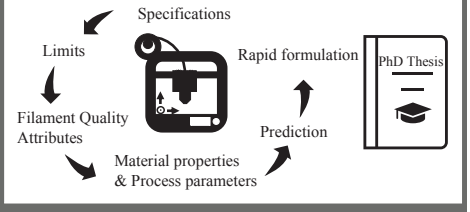
Feiler probability plot

(MFA-EPO-StA)-Silica (13.2%-EPO-5.1%)-14.5%



An end of a story is start for a new one

- Polymer mechanical properties and drug-polymer miscibility.
- Drug load and Drug-Polymer Process space consideration:
  Dispersed on molecular level (transmission or separation plasticization effect) or heterogenous solid dispersion (Particle size, shape, concentration, and ....)
- Additives: Plasticizer (improve ductility), Filler (improve toughness).
- Ingredients Ratio Optimisation:
  DoE of the ingredients to find the optimum formula for 3D printing



The End

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REFERENCE

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