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SLS 3D printing technology

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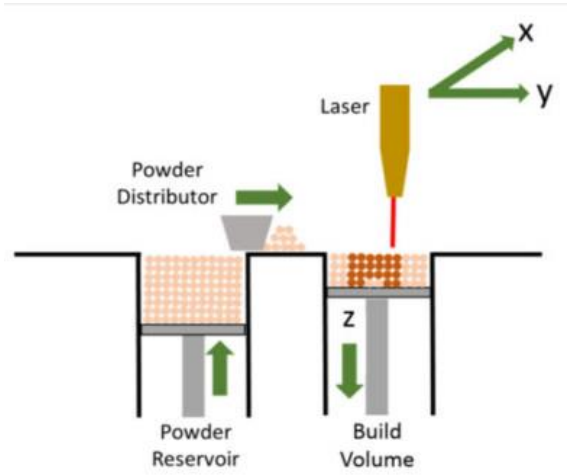
SLS – selective laser sintering

- Analogic to binder jetting
- Powder is melt-fused by laser



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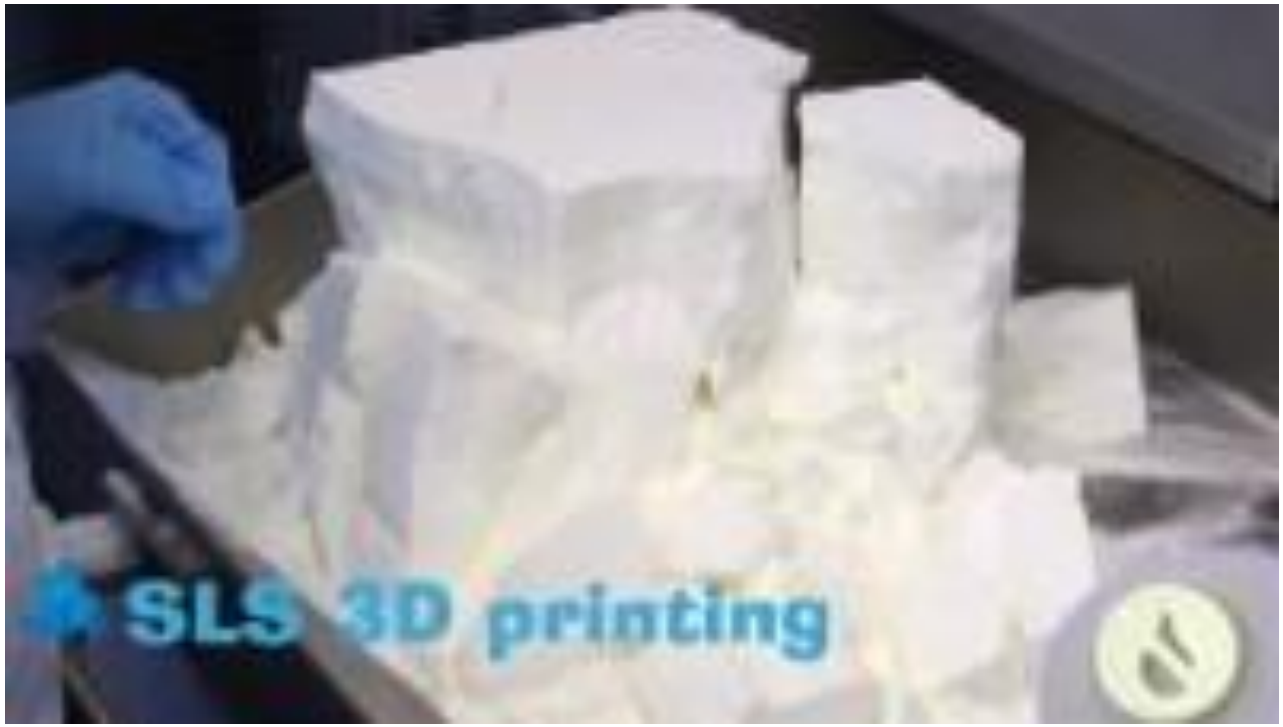
SLS – selective laser sintering

Principle and history

– Pioneered by Carl Deckard in 1988 – heavily patented and rather industrial applications, but after patents expiration (2012) affordable machines boomed



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SLS – selective laser sintering

- Good adsorption of laser energy is cruciall!
  - Badly adsorbing material – addition of adsorber (pigments), heating of bulk material, tuning the speed of laser
- Unsuitable for light and thermally sensitive compounds
- As in binder jetting – adequate particle size distribution and flow properties of powder are required
- **Possible excipients**: *waxes, polyvinylalcohol, polyethyleneglykol, methacrylates (Eudragit)*

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SLS – selective laser sintering

Machines

- Sintratec KIT
- only „DIY“ SLS printer (kit)
- optional materials
- no control of LP
- 110*110*110 build volume
- € 6 000

BANKRUPCY – 5/24

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SLS – selective laser sintering

Machines - desktop

Sinterit LISA
€ 10 000

Formlabs FUSE 1
€ 10 000

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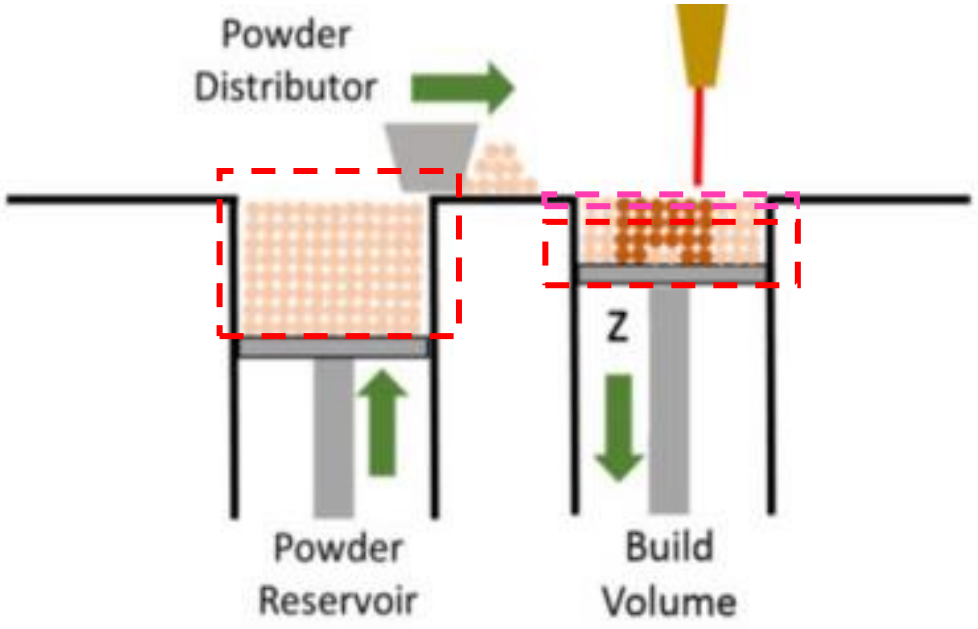
Critical parameters

- Bulk temperature - should not exceed lowest melting temp of composition
- Surface temperature – few degrees higher than Bt, IR lamps



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Critical parameters

Energy deposited (ED):

higher energy deposition leads to thourough melting, related to:

- laser speed (LS) and power (LP)
- layer height (LH)
- path distance (PD)

$$ED = \frac{LP}{LH \times LS \times PD}$$

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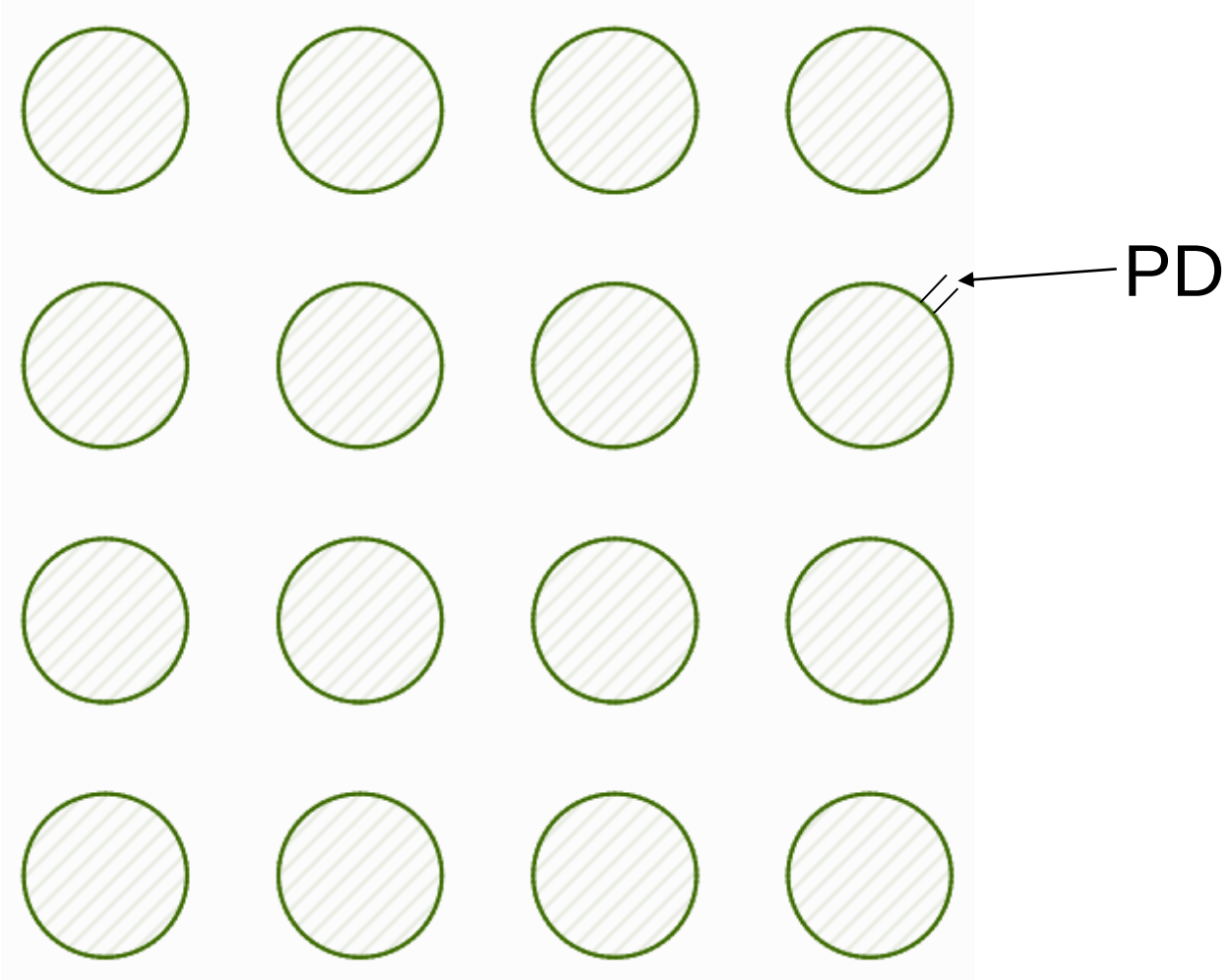
Slicing



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Overall considerations

- Particle size

  average diameter should be 1/3 - 1/5 of LH

- Recycling

  bulk heating may affect glass transition temperature (Tg)

  used material is to be mixed in 1 to 3 ration with „virgin“ one

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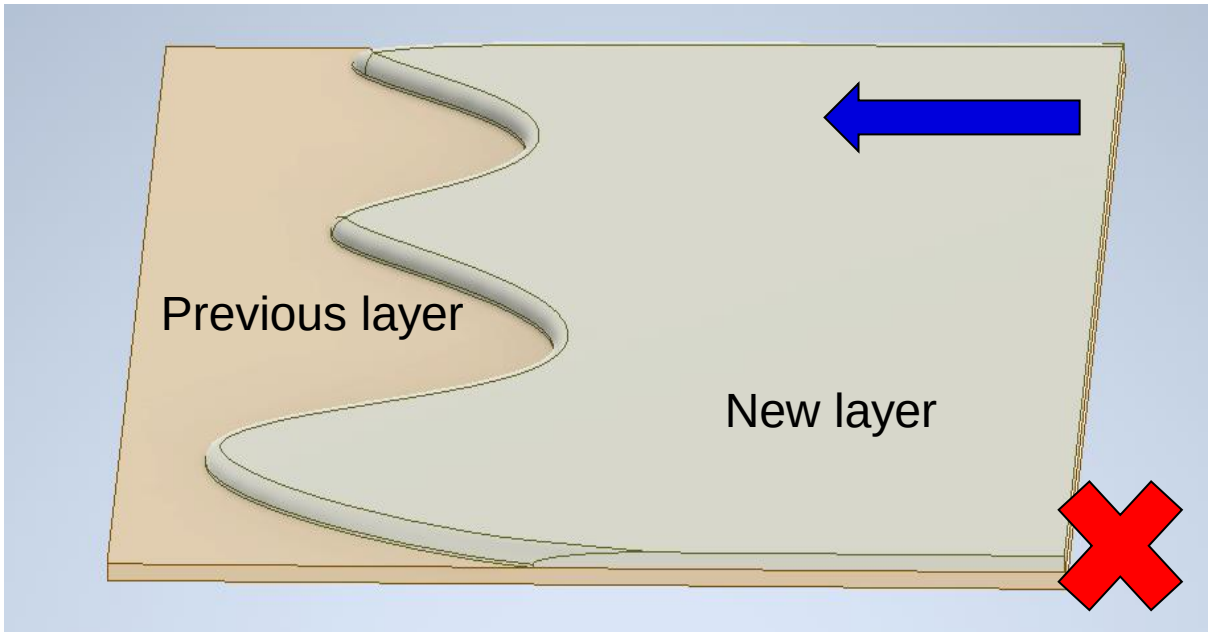
Overall considerations

Flow properties - powder should be able to form an undisrupted layer repeatably



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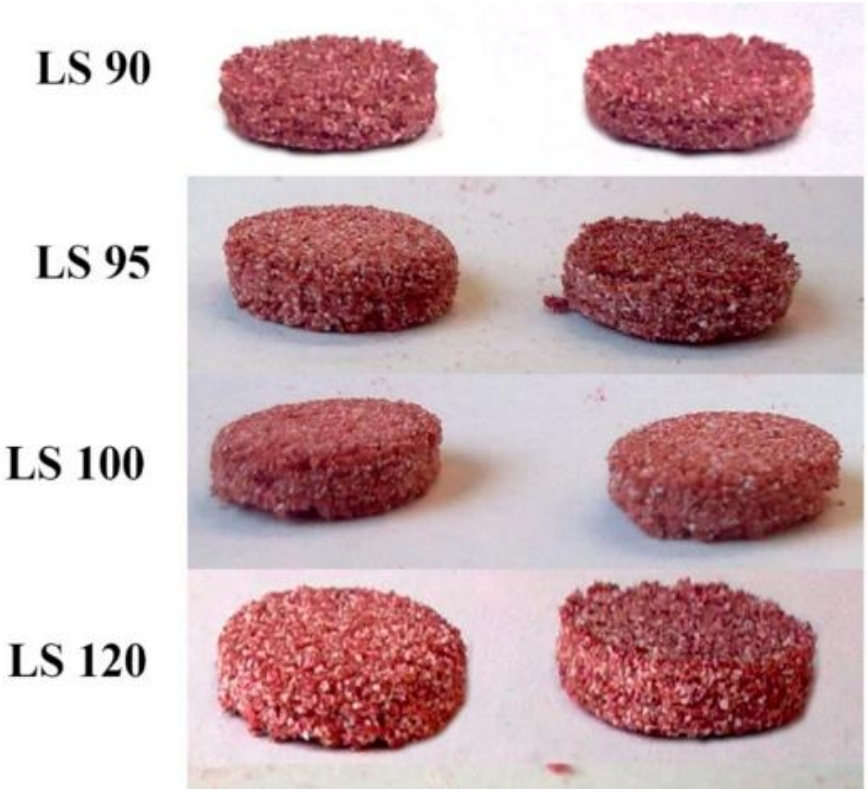
Overall considerations

Dimensional accuracy - interplay between print parameters



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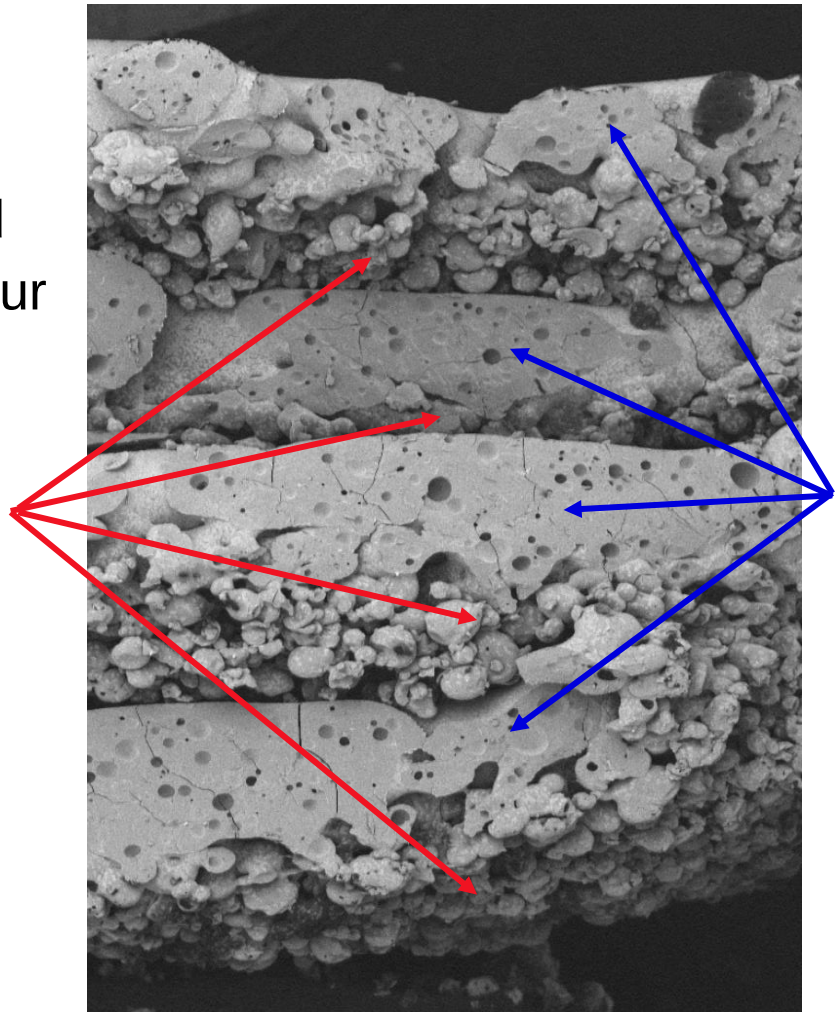
Overall considerations

– Layer adhesion
full layer should be sintered
otherwise capping may occur

Unmelted
discreete particles



Fully
melted

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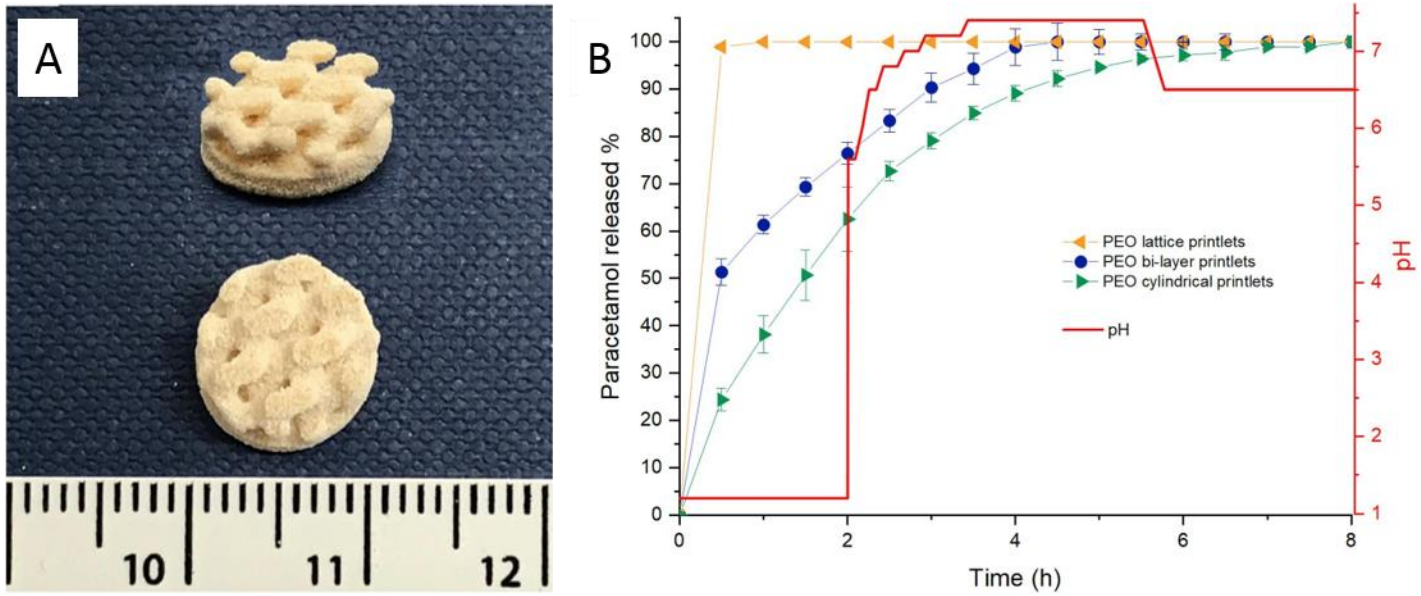
Example of experimental use

Tablet combining immediate and prolonged release



Fina, F.; Goyanes, A.; Madla, C.M.; Awad, A.; Trenfield, S.J.; Kuek, J.M.; Patel, P.; Gaisford, S.; Basit, A.W. 3D printing of drug-loaded gyroid lattices using selective laser sintering. *Int. J. Pharm.* **2018**, *547*, 44–52, doi:10.1016/j.ijpharm.2018.05.044.

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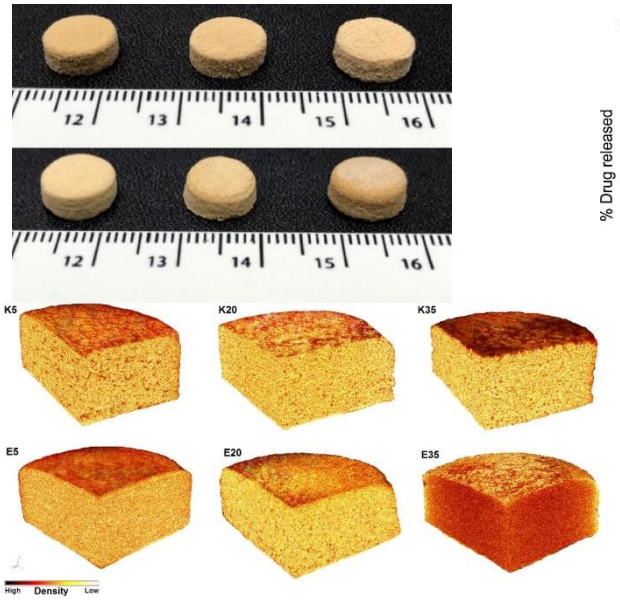
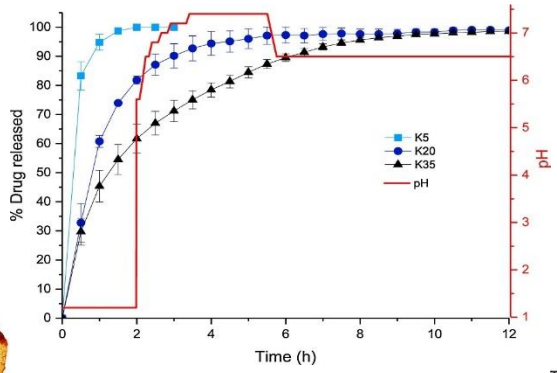
Example of experimental use

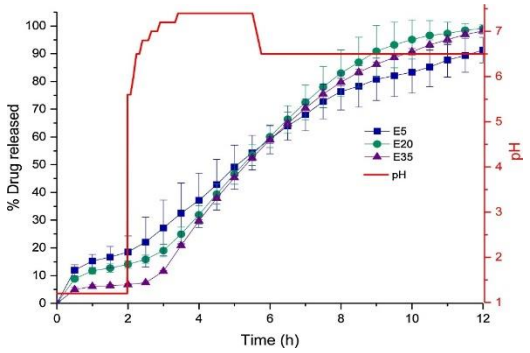
Paracetamol containing tablet – tuning of release profile by melt level





←**Kollicoat IR**

Eudragit L →



Fina, F.; Goyanes, A.; Gaisford, S.; Basit, A.W. Selective laser sintering (SLS) 3D printing of medicines. *Int. J. Pharm.* **2017**, *529*, 285–293, doi:10.1016/J.IJPHARM.2017.06.082.

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And that´s all….

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