3D Printed Adsorbents for Metal Recovery

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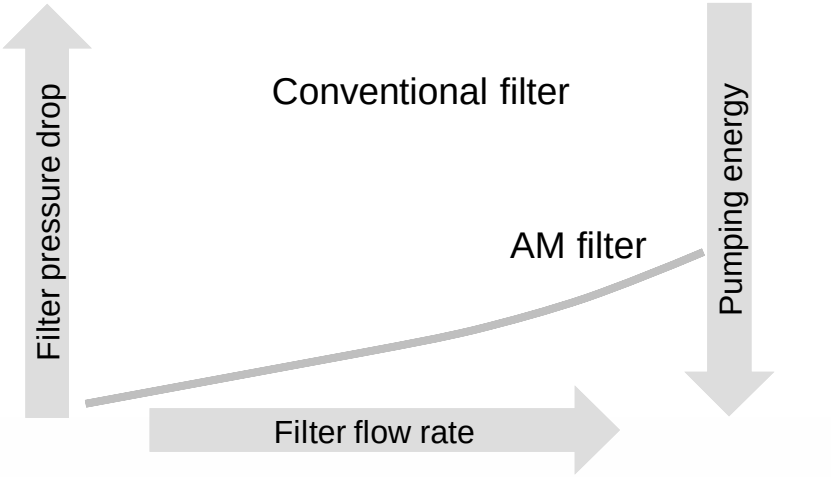
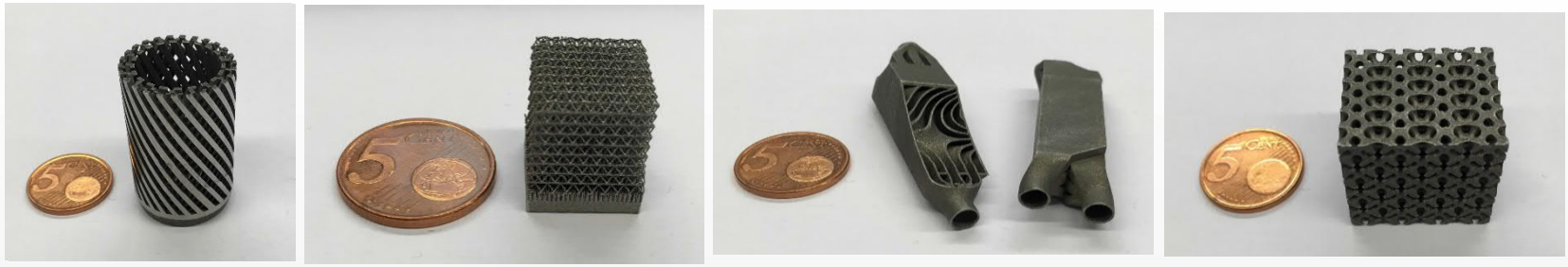
Why 3D-printing?

- Porosity and geometry can be optimized
- Fluid channels and holes can be aligned with fluid flow when turbulence decreases → pressure drop decreases and less energy is needed for pumping.
- These kind of structures are possible to manufacture only with 3D-printing (additive manufacturing, AM).

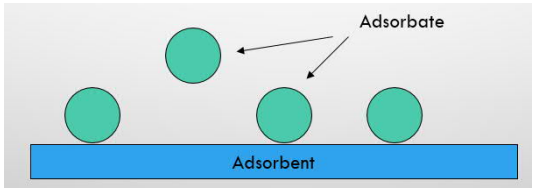




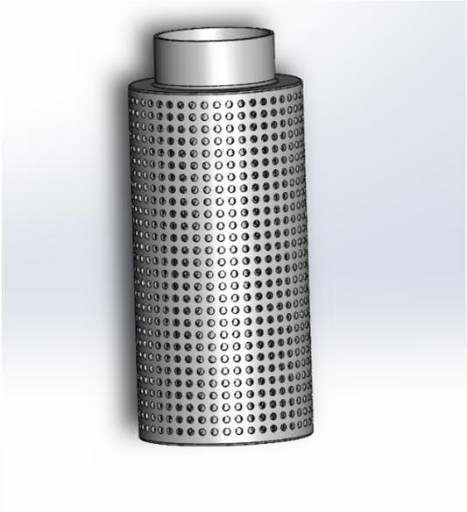
Designs by LUT Laser

AM in the production of adsorbents/scavengers

- Adsorption is based on the interactions between the surface and species in the liquid or gas phase



- Limited by the amount of active sites on the surface (surface area), diffusion, reaction kinetics etc.
- AM offers possibility to optimize the shape, size, and flow properties → enhancing interactions



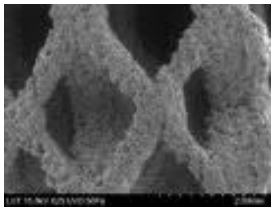
Design by LUT Laser

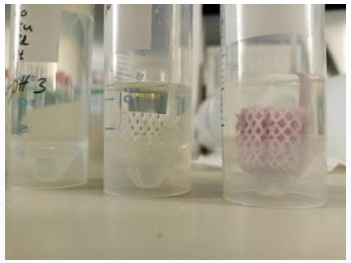
Our premilinary experiments:
Gold recovery by 3D-printed nylon adsorbents

Test solution (pH 3)	After adsorption
Co 2.9 ppm	Co 2.9 ppm
Au 7.3 ppm ⇒	**Au 0.2 ppm**
La 36 ppm	La 36 ppm
Pt 6.7 ppm	Pt 6.5 ppm
Pd 6.0 ppm	Pd 5.7 ppm

Test solution (pH 5)	After adsorption
Co 4.9 ppm	Co 4.9 ppm
Au 6.6 ppm ⇒	**Au 0.4 ppm**
La 62 ppm	La 62 ppm
Pt 6.0 ppm	Pt 5.9 ppm
Pd 6.4 ppm	Pd 6.0 ppm

Selective laser sintering

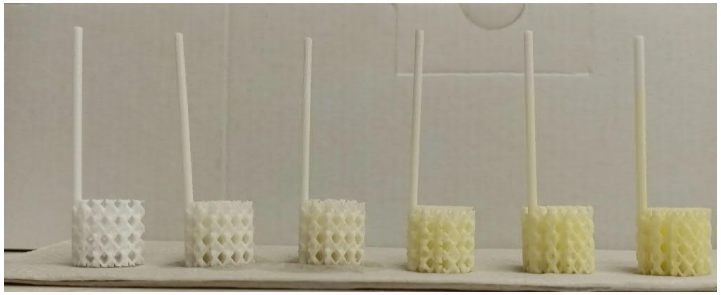


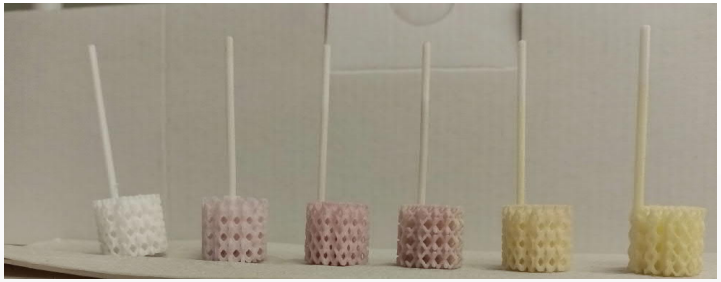


Our premilinary experiments:
Gold recovery by 3D-printed nylon adsorbents

Gold concentration in the initial solution

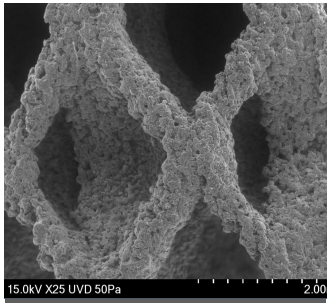
0 mg/l 10 mg/l 50 mg/l 100 mg/l 150 mg/l 200 mg/l



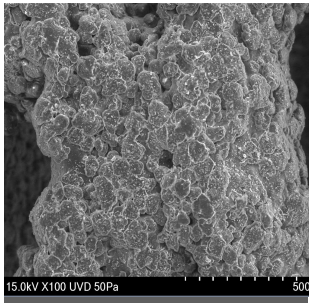


Directly after adsorption The colored ones show adsorbed gold from the solution

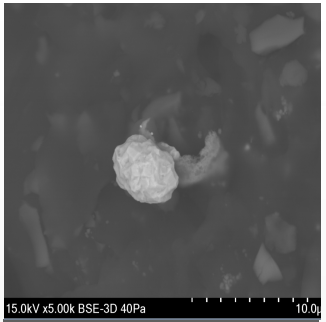
After 24 hours gold nanoparticles formed on the surface change the colour reddish



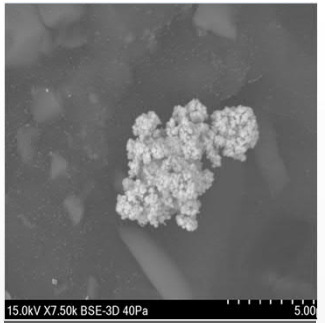
Magnification X 2 mm



Magnification X 500 µm

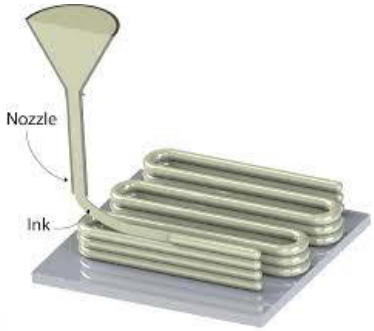


Magnification X 10 µm

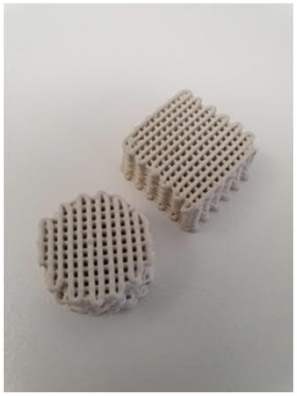


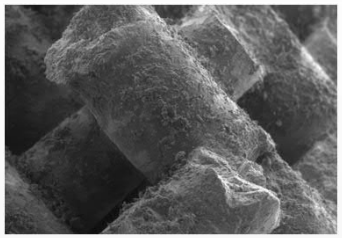
Magnification X 5 µm

Our premilinary experiments: 3D-printed geopolymers for organics removal

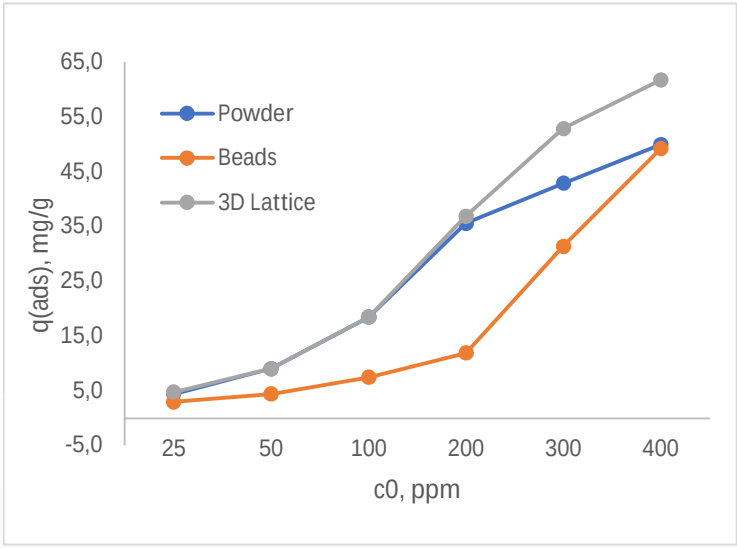


Direct ink-jet writing
(University of Padova)





Adsorption of
Orange II

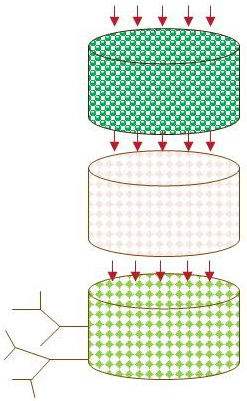


Sea4Value project

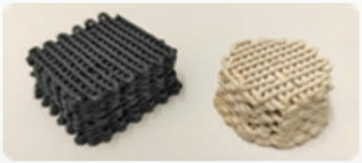
LUT task: Production of selective 3D-printed adsorbents

- Adsorption/ion-exchange is effective and selective way to recover trace amounts of metals
- Especially, selective ion-exchange resins are widely applied
- In Sea4Value project:
  - Inks and printing powders will be prepared by mixing matrix materials (polymers) with selective ion-exchange resins
  - Printing will be conducted by SLS or DIW using optimized models
  - 3D-printed modules will be tested for selective recovery and concentration of Sc, In, V, B, and Mo
  - Adsorption/desorption cycles will be optimized

3D-printed selective
"adsorption modules"



Special functionalities such as IDA, EDTA, phosphonates

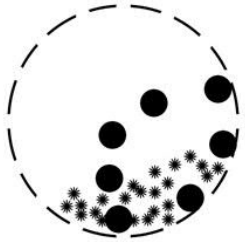


Production of 3D-printed adsorbents

Element	Resin
In	Lewatit TP207
Sc	Chelex 100
Mo	Resin D314
V	Valox resin 312
B	Dowex 2x8

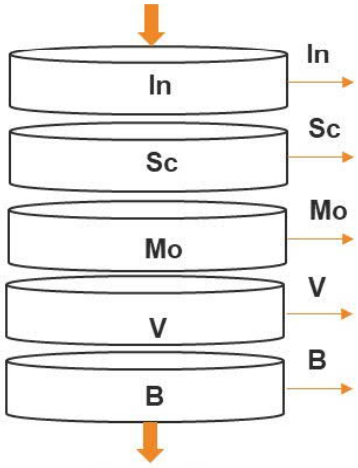
Ball mill

Particle size aprx. 50 micron



Brine solution

In, Sc, Mo, V, B, Li, Rb, Ga



Mix PA12 powder with resin powder 10 wt%

AM of adsorbents by 3D-printer

Thank you!

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