3D printed Ceramic Water Filter

Stichting Water for Everyone

SYMBIOSHAPE

UNFOLD

provinsje fryslân
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Presentation content

- Ceramic water filter project
- Research approach
- Results & recommendations
- Questions

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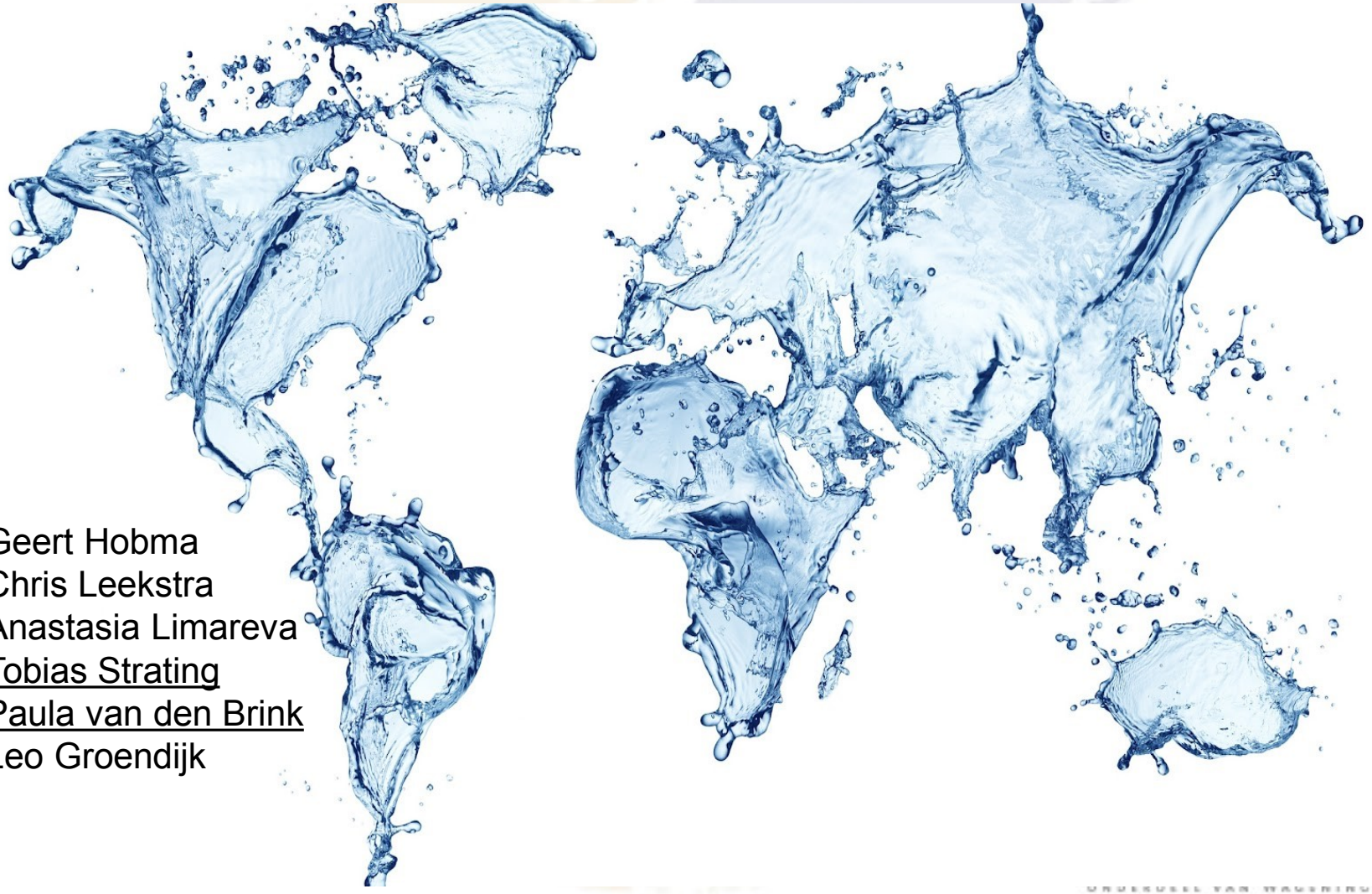
3D ceramic water filter

Innovations 4 Sustainability



- Geert Hobma
- Chris Leekstra
- Anastasia Limareva
- Tobias Strating
- Paula van den Brink
- Leo Groendijk

Reality in most of the world

Why ceramic water filters (CWF)?

- Use of locally available materials (clays, organics)
- Low tech
- Community scale production
- It is already done, accepted

Why 3D printing of CWF?

- More constant quality
- Other shapes (combination other techniques)
- Household level

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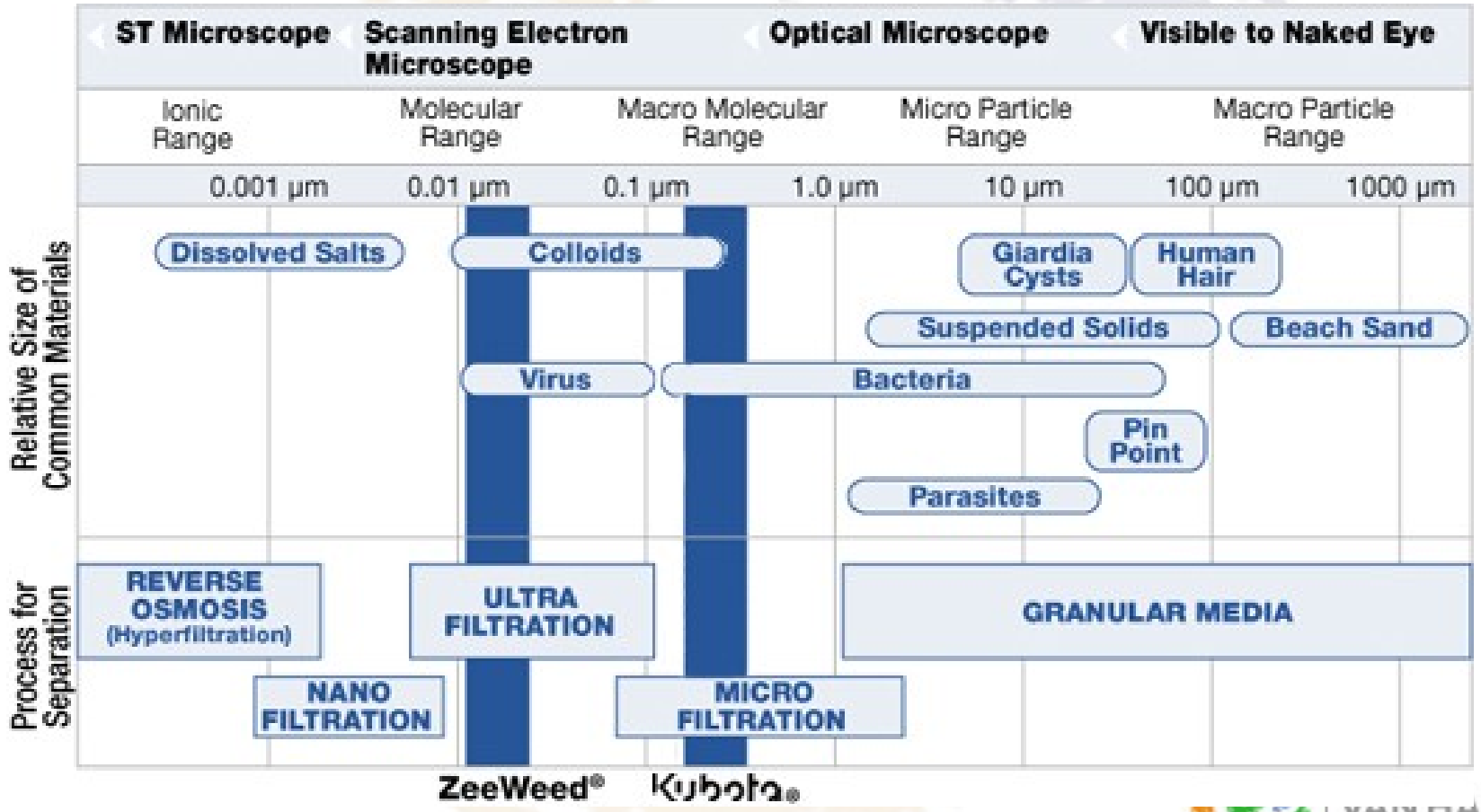
Filtration spectrum



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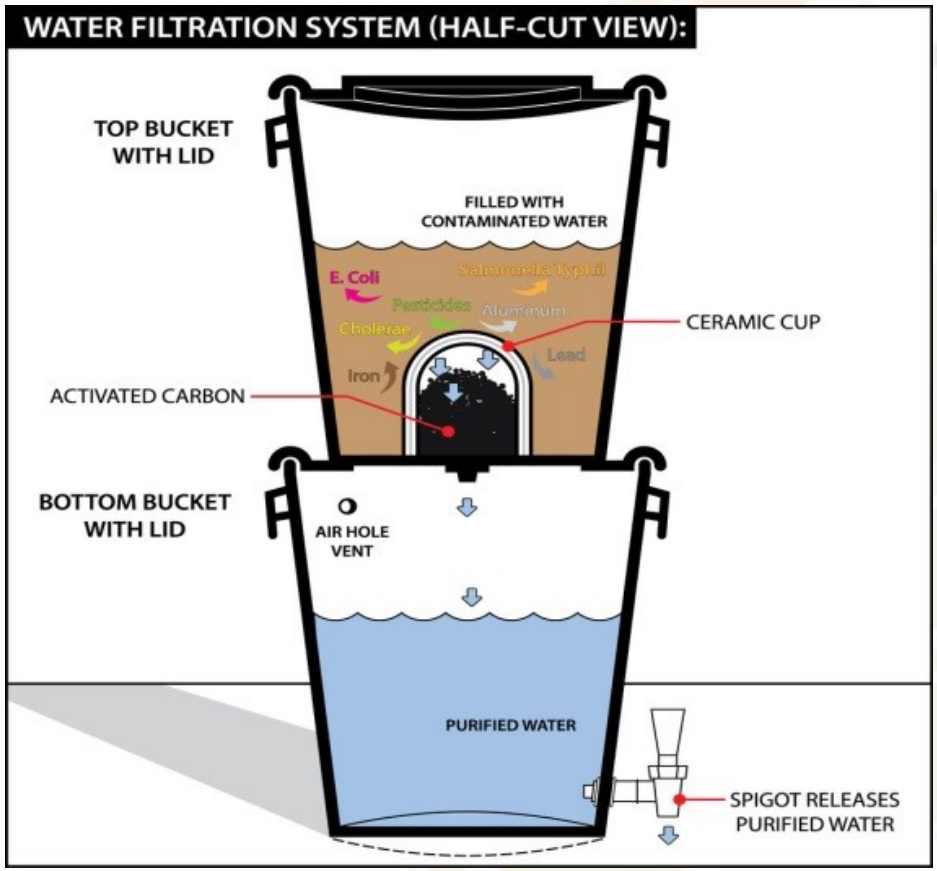
Ceramic water filters (CWF)



3D printing vs traditional method

1. Preparing the raw material
2. Mixing the raw material + silver

3. Making blocks and press them into filters → 3D printing

4. 'Reshaping' and labeling → 3Dprinting

5. Drying
6. Firing
7. Testing flow rate

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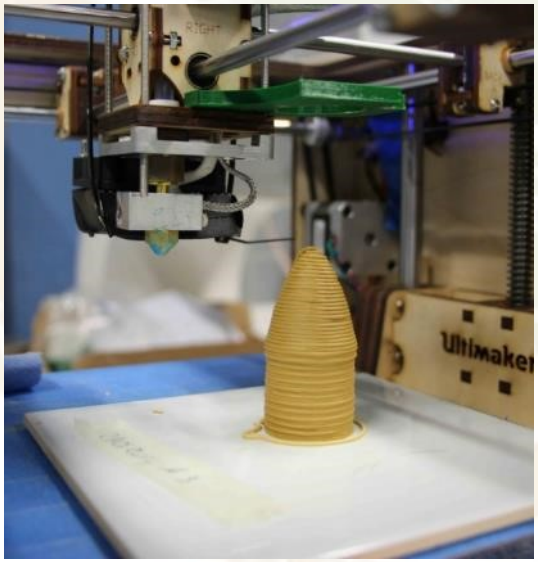
Research approach

Recipe → Preparation of clay → 3D printing → Drying & firing → Water quality analysis



Recipe

Clay

- Terracotta

Organic material

- Sawdust
- Wheat flour

Water

- Tap water

Preparation of clay

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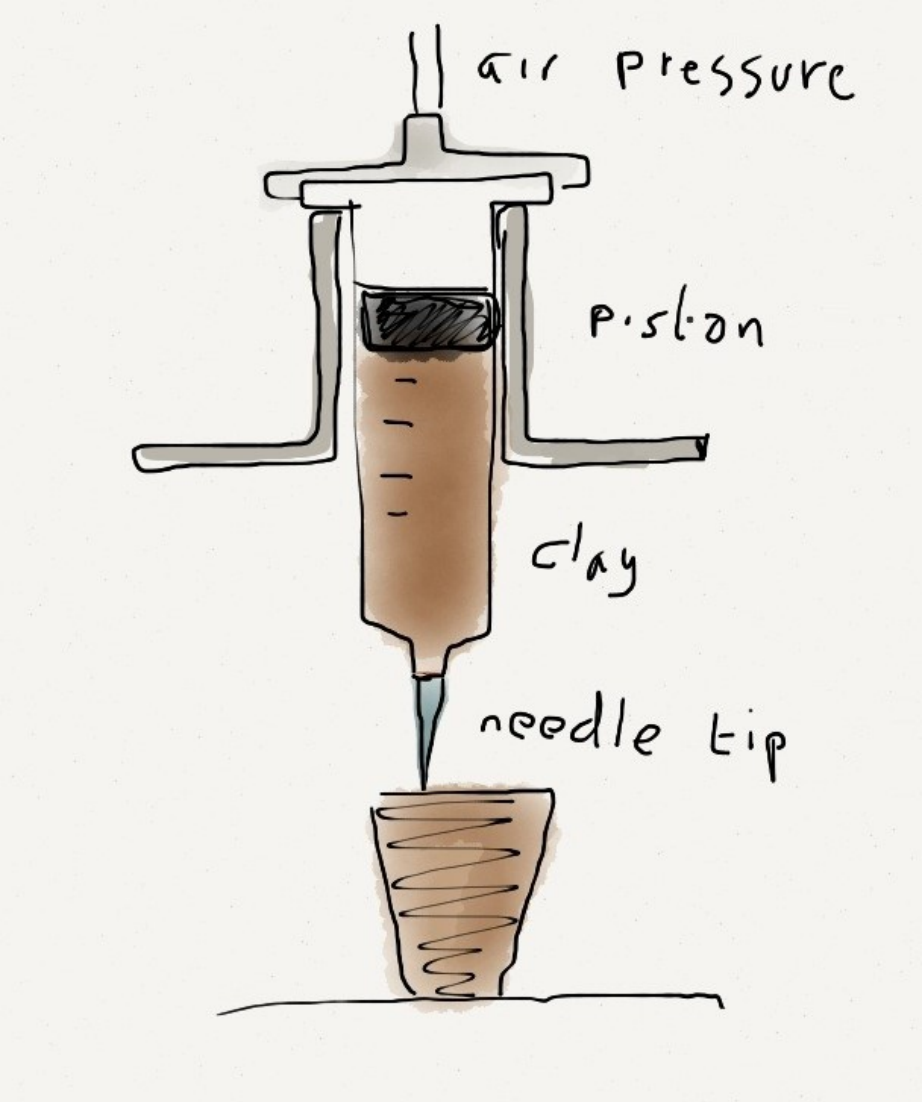
Het Systeem



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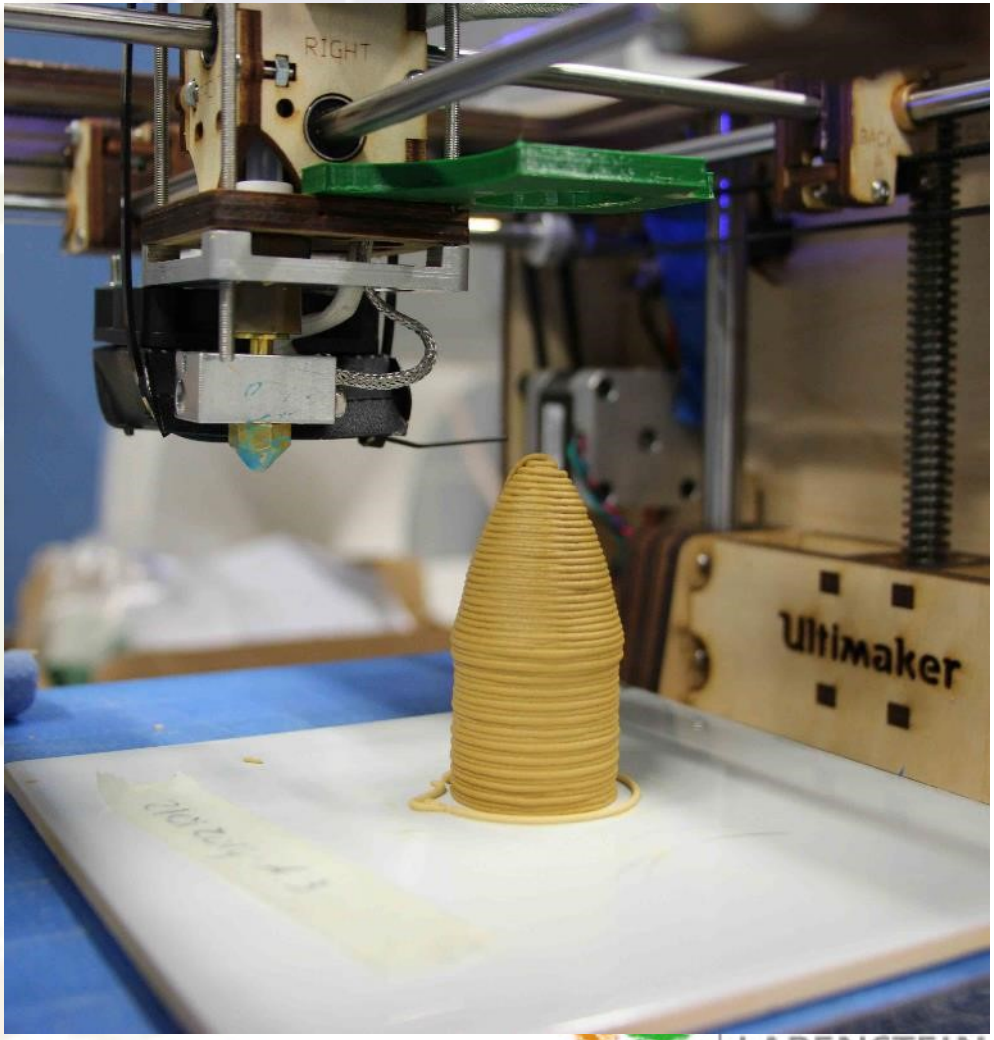
Ceramic 3D printing



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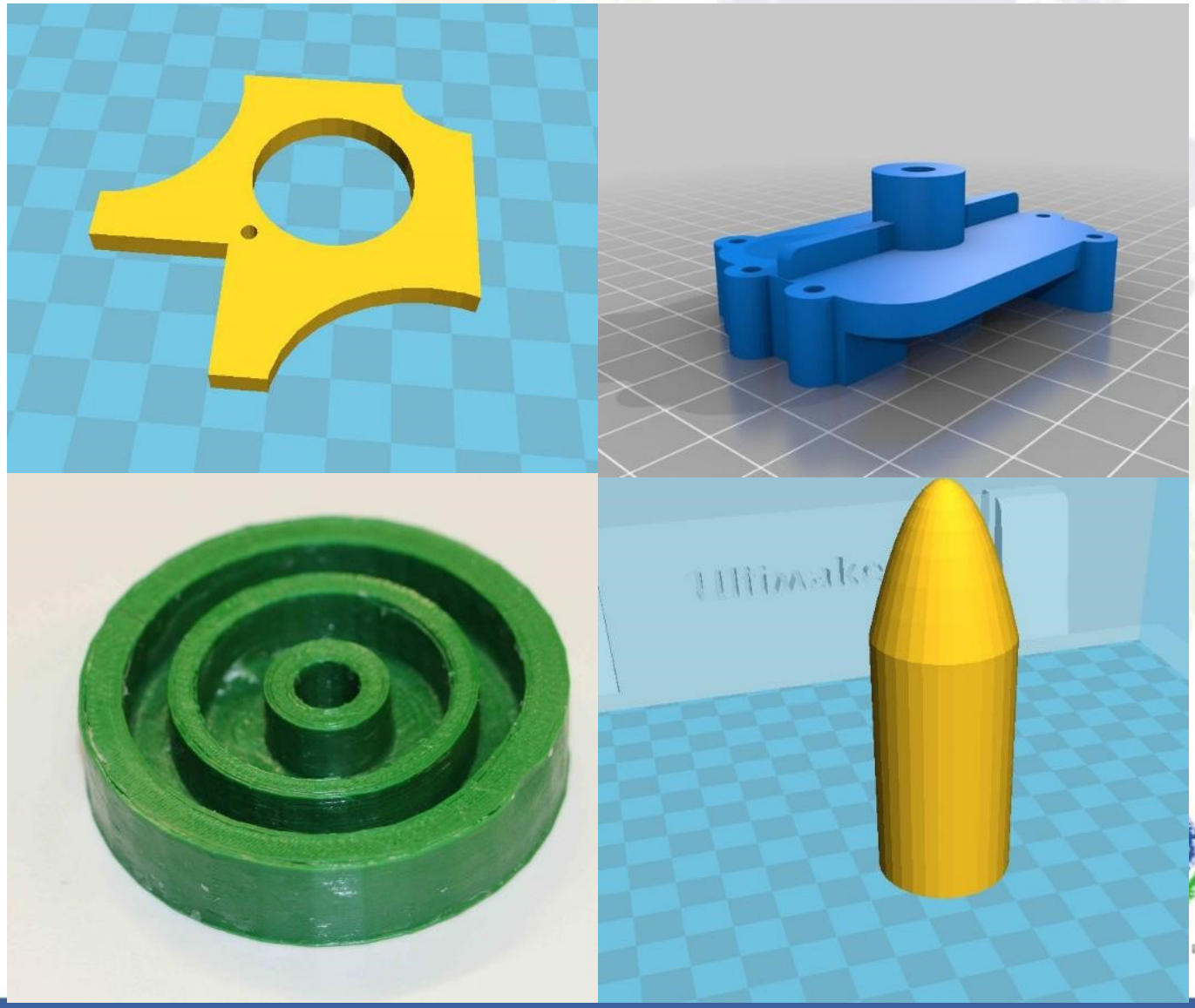
3D design



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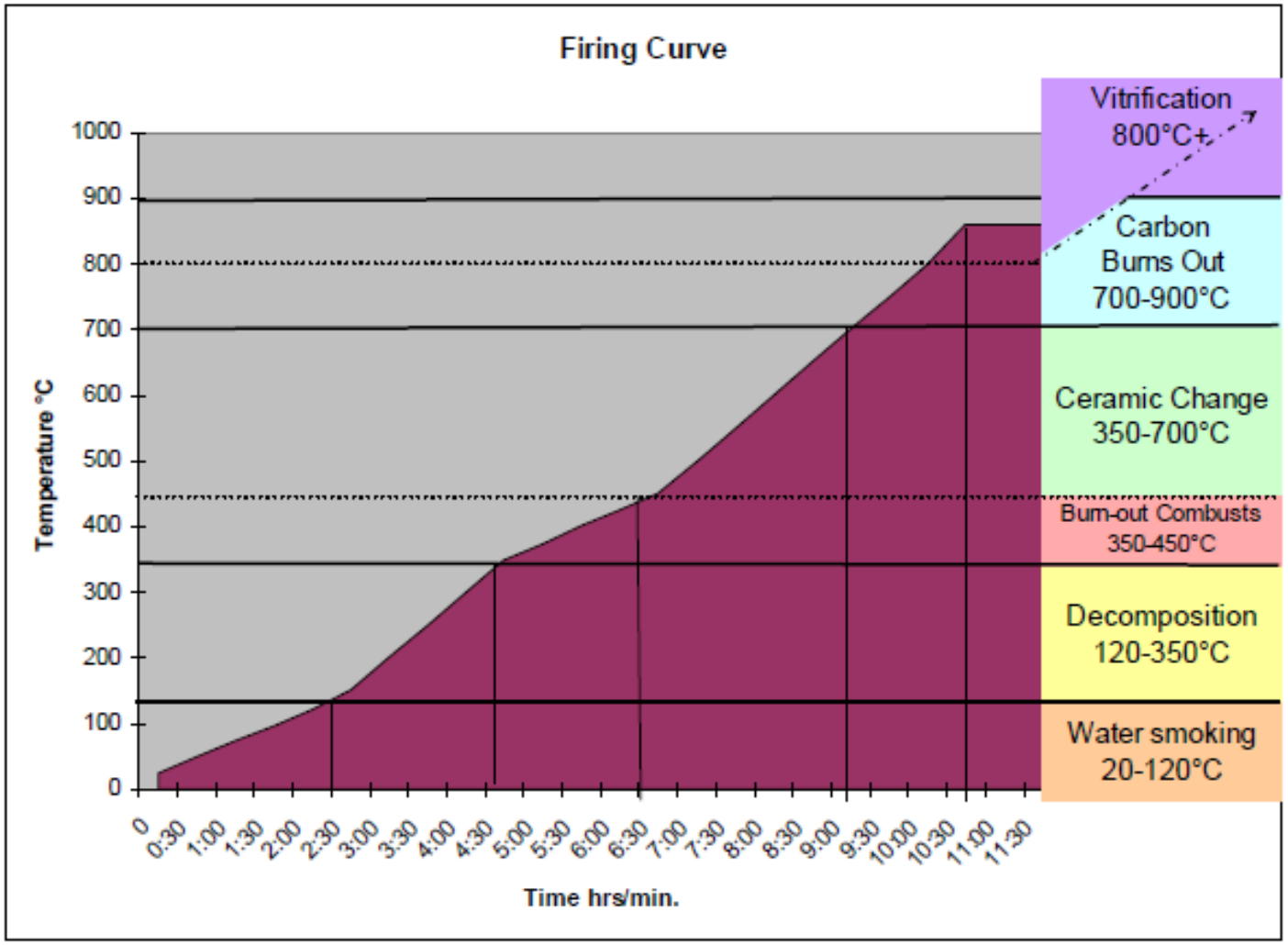
Drying &Firing



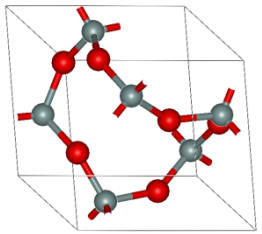
The Ceramics Manufacturing Working Group (2011)

Chemical changes during baking

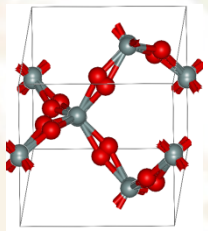
1. Quartz inversion (around 570°C)

2. Chemically bound water released

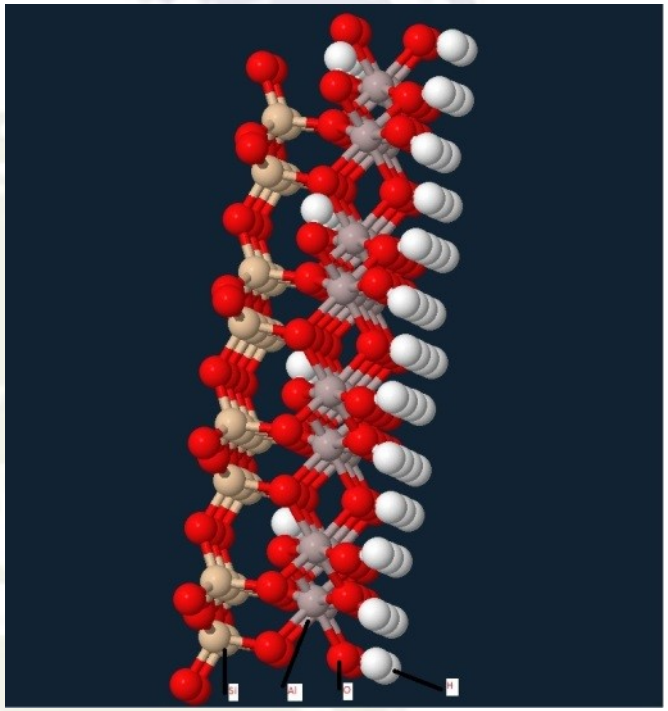
3. Carbon burned out



Alpha-quartz



Beta-quartz



Kaolinite ($Al_2Si_2O_5(OH)_4$)

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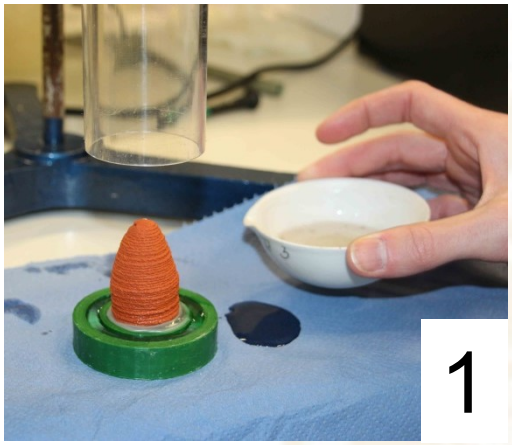
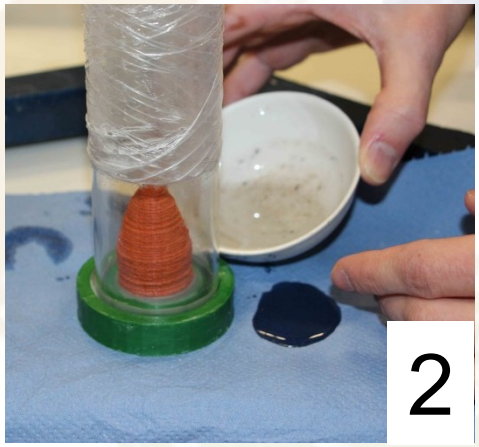
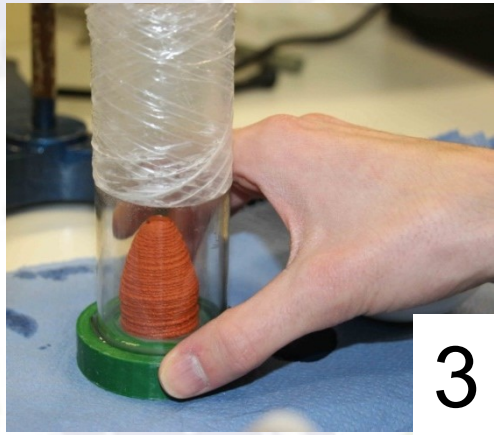
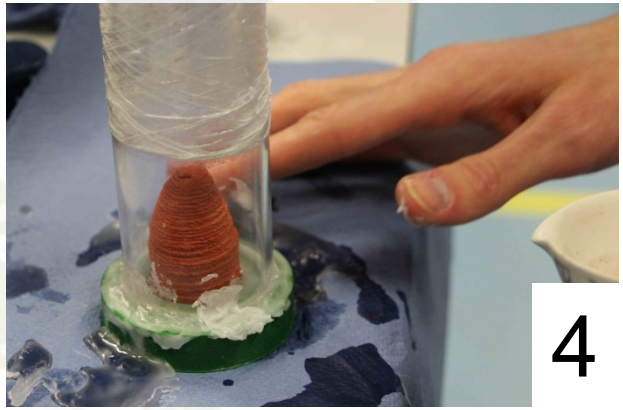
Testing flow CWF prototypes







1. Placing CWF in shape
2. Pouring hot paraffin in the shape gaps
3. Make sure all space is filled with paraffin
4. Manual addition if necessary



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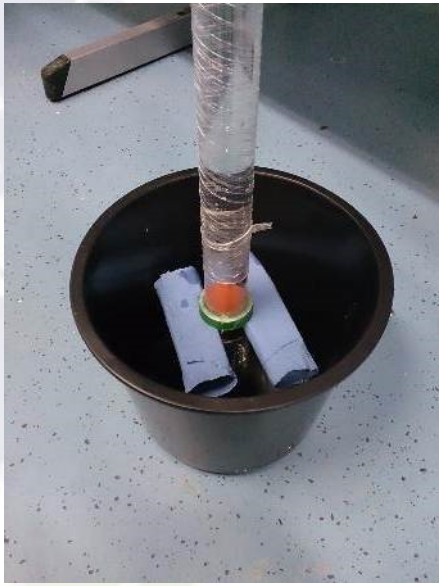
Testing flow CWF prototypes

Batch	Surface filter (cm^2)	Time (h)	Filtered volume (ml)	Flux (L m^{-2} $h^{-1)}$	Perm (K) (L m^{-2} h^{-1} bar^{-1})
12 clay	32,2	20	190	3	30,6
15 sawdust	32,2	1	131	40,1	408
18 flour	32,2	1,5	280	58,0	592
18 flour	56,55	1	335	59,2	604



All measurements done at 1 m water column = 9,806 65 kPa = 0,098 bar

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Evolution of 3D CWF prototype

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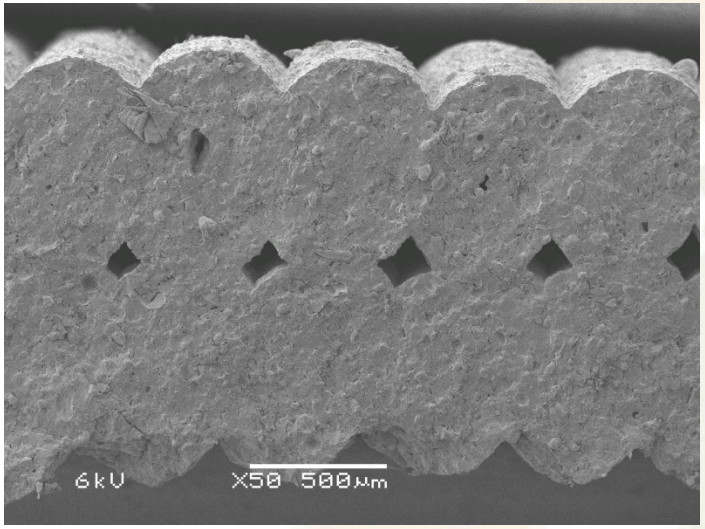
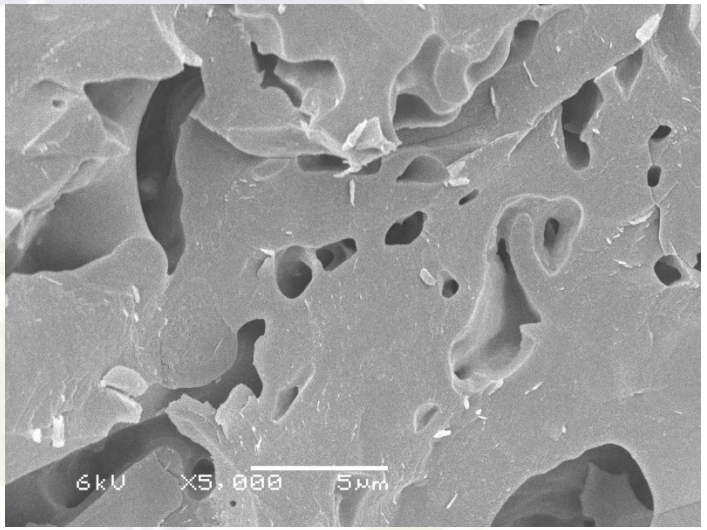
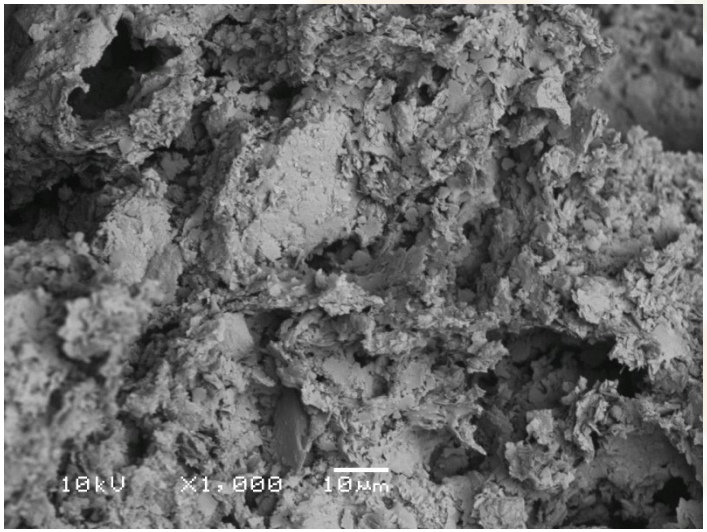
Evolution 3D CWF SEM



Wall



Cross section



Including sawdust

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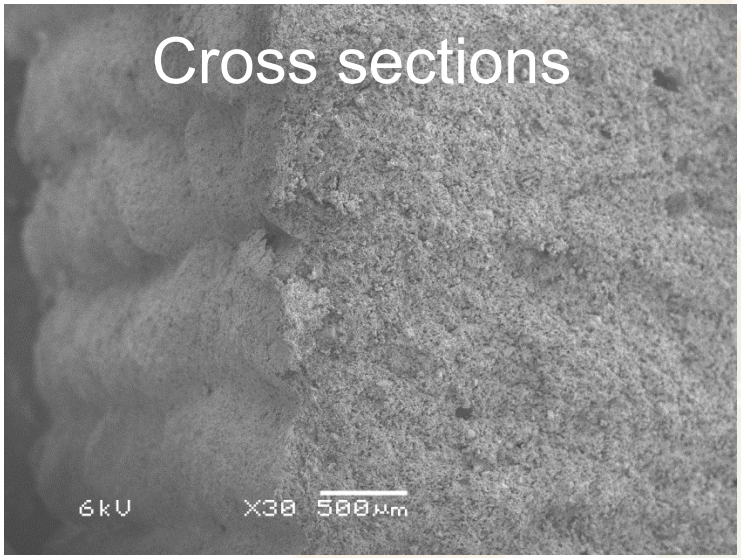
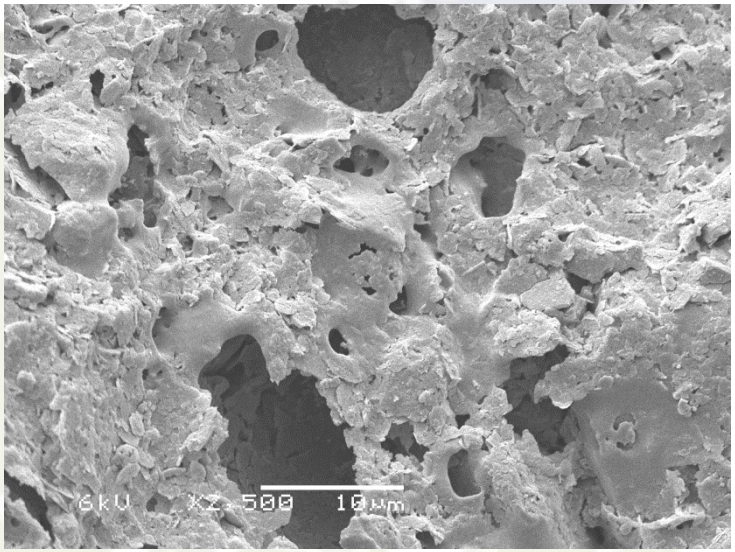
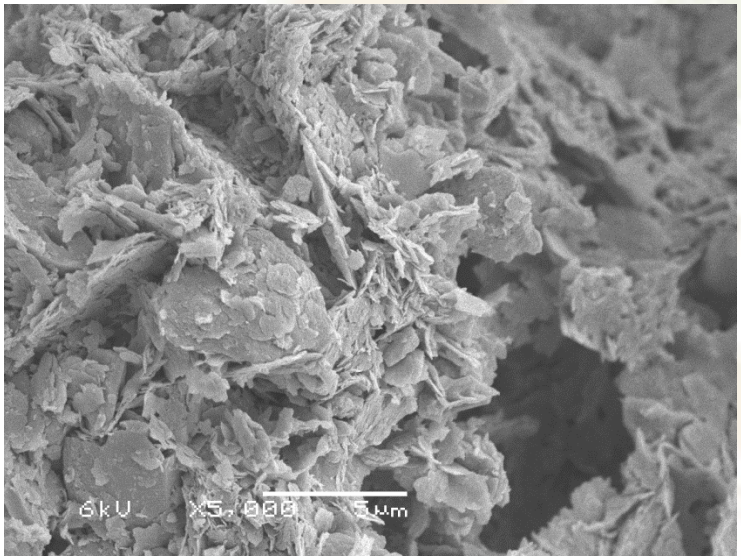
Evolution 3D CWF SEM





Surface



Porosity vs pore size

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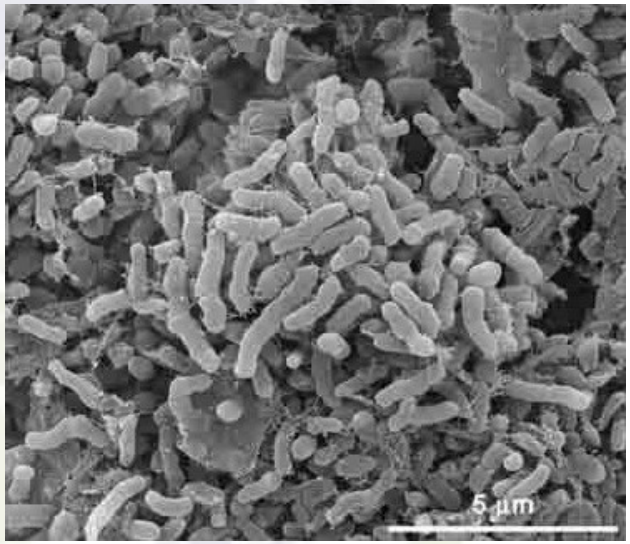
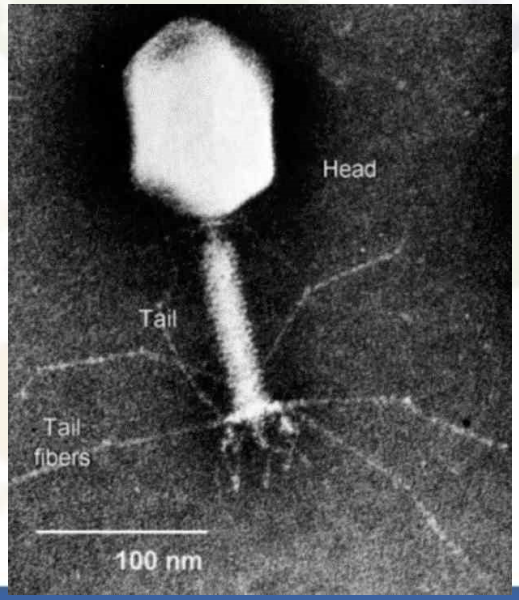
Theory water quality analysis

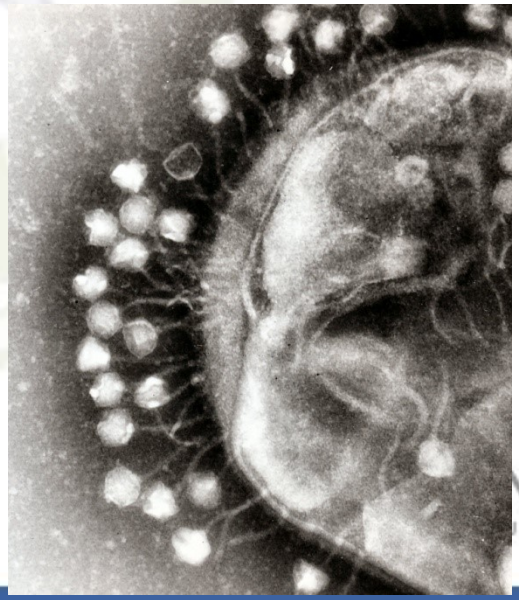
Microbiological parameters

Detection and enumeration of :

- E.coli (CFU/100ml at 37°C)
- Total count (CFU/100ml at 22 and 37°C)
- Viruses- Bacteriophages







Experiment WWTP effluent

influent effluent sand filter effluent CWF

Blue colonies + gas → *E.coli*
Other colonies + gas → coliforms

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Actual research results

✓Right recipe clay

✓Working 3D printing system

✓Established baking process

✓A porous CWF with right flow

✓Theoretical preparation of water analyses

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Recommendations further research

Manufacturing process

- Use local types of clay´s
- Other oven types (DIY)

Water quality control

- Removal efficiencies of E.coli, total count and viruses
- Influence biofilm on removal efficiencies
- Use of activated carbon/colloidal silver/nanosilver

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Questions are welcome

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