3D Inkjet Printing

Digital additive manufacturing

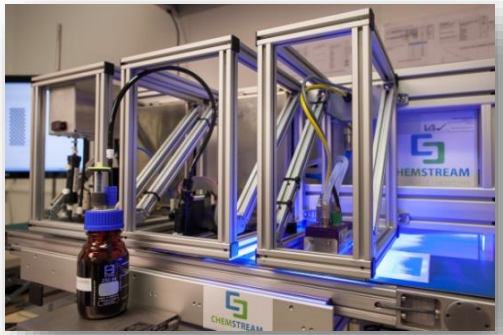
CHEMSTREAM
SUSTAINABLE CHEMISTRY

Dr. Marin Steenackers
ChemStream

ChemStream: The Independent Chemical R&D Company

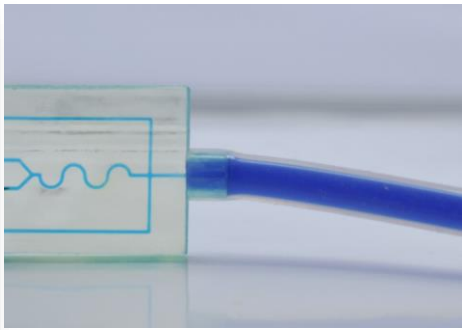
- Core competence: develop innovative materials from sustainable chemistry: from design to industrial prototype
- Core activities:
  - Innovative contract research
  - Design and synthesis of (bio-based) functional chemistry (monomers, polymers, surfactants, adhesion promotors…)
- Main deliverables:

Inkjet inks



Nano dispersions

Functional 3D printing materials



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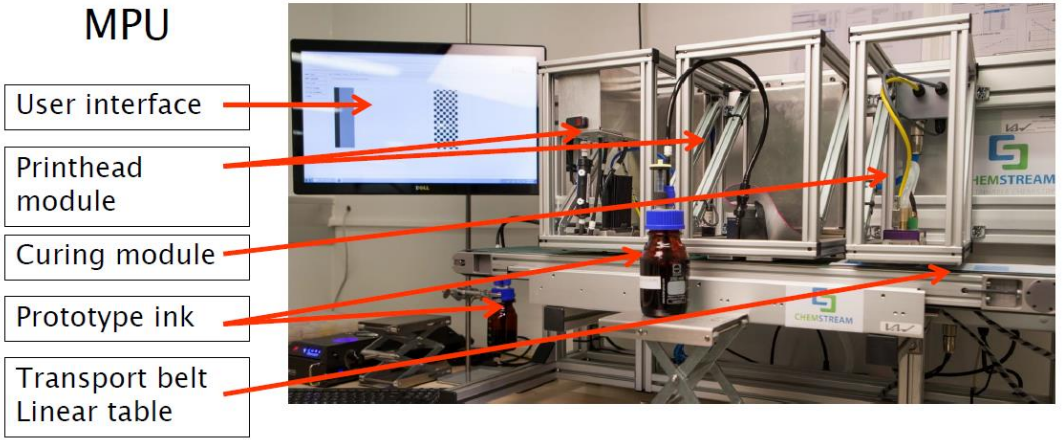
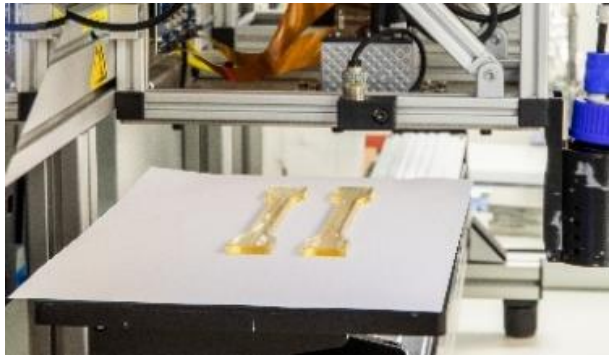
ChemStream: The Independent Chemical R&D Company

- **Founded in April 2010**
- **Staff profile (14 FTE, 11 PhDs)**
  - Chemistry (12)
  - Material Science (1)
  - Bio Engineer (1)
- **Located near Antwerp – Belgium**
- **Lab-facilities (550 m²)**
  - Organic Synthesis
  - Chemical Formulation
  - Characterization
- **Prototype production facility**
  - Coatings: 250 L batches
  - Inkjet inks: 25 L batches

Inkjet @ ChemStream: Modular Printing Units

- Mimic of an in-line printing process
- Fast iterations of ink prototypes
- Different inkjet printheads
- **3D printing**





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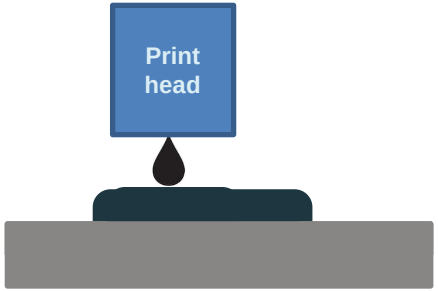
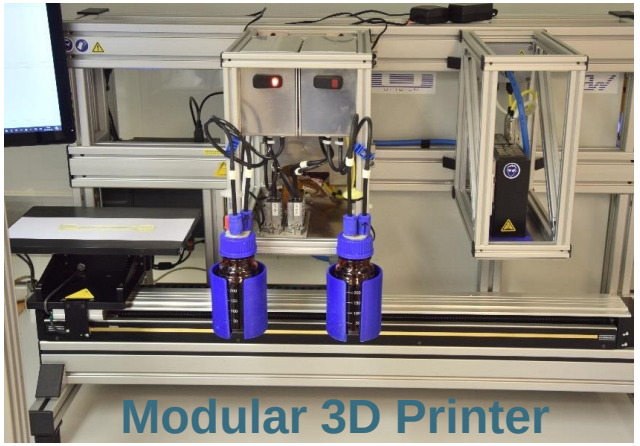
What is 3D inkjet printing





- ❑ UV-curable inkjet inks
- ❑ Phase change inkjet inks

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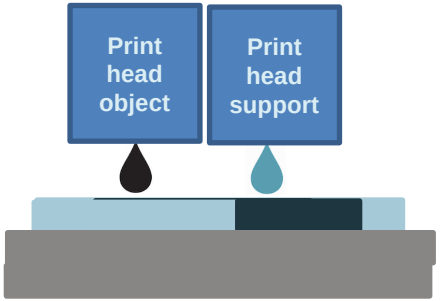
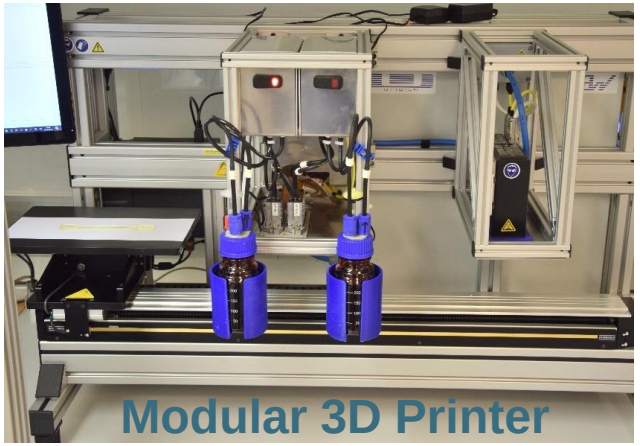
What is 3D inkjet printing

- Printing with support ink
  - Allows complex geometries
  - Sharper structures





- Dissolve support ink after printing

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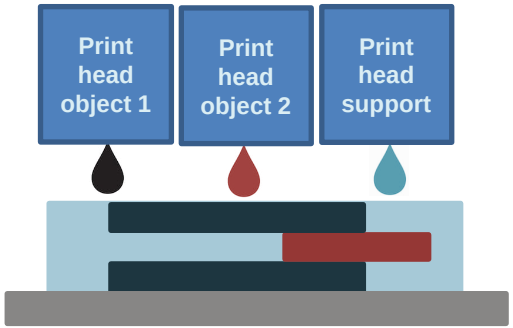
What is 3D inkjet printing

- Printing with different object inks
  - Allows multimaterial printing
  - Embedded functionality



Why Inkjet 3D Printing?

- High resolution
- Optically smooth objects
- Multi-material
  - Different material properties
  - Embedded functionality
  - Full color
- High productivity

Focus on digital additive manufacturing

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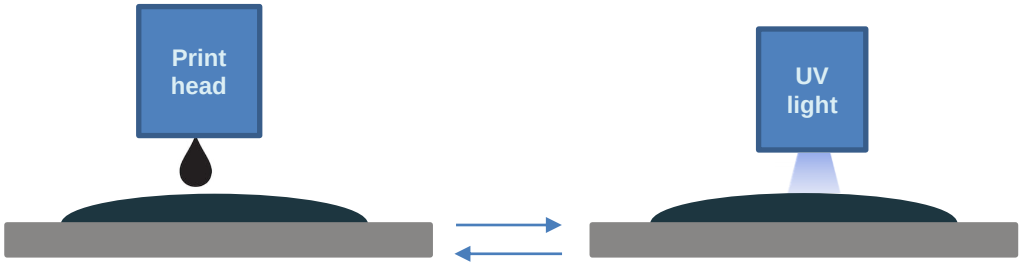
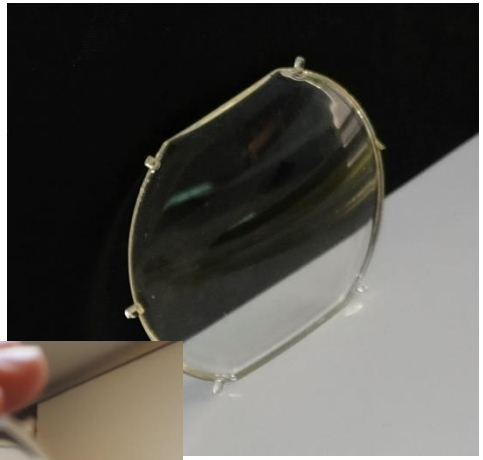
3D printing of lenses: a unique technology





- ❑ Printing without support ink
- ❑ Optically flat surface without post-polishing

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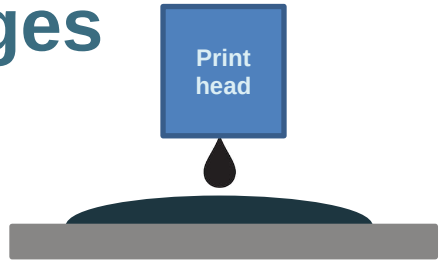
3D printing of lenses: material challenges



- High transparency and low yellowing
  - Photoinitiators
  - Stabilizers
- Overprintability
  - Wetting agents
  - Balancing entire formula
- Material properties
  - Impact resistance
  - Hardness
  - Refractive index

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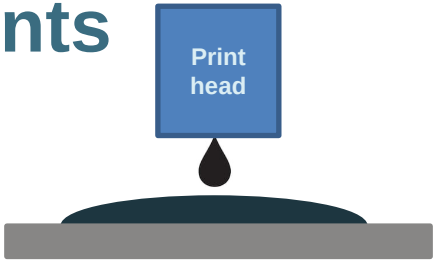
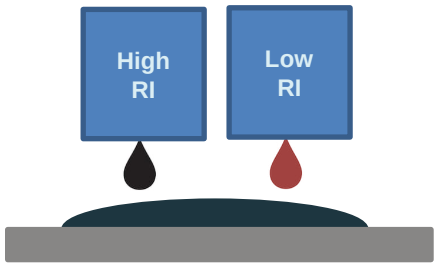
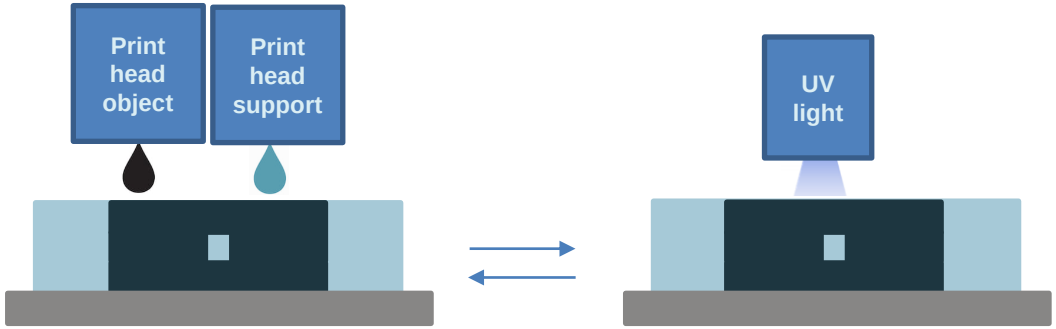
3D printing of lenses: future developments

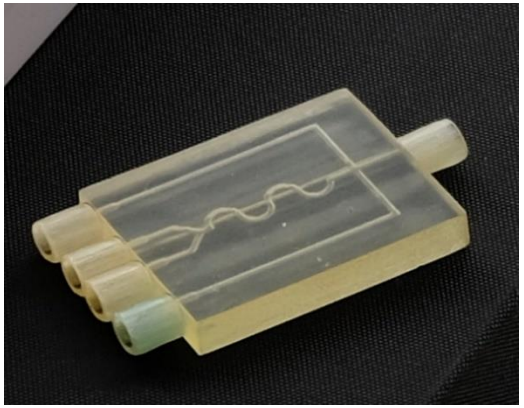


- Micro lenses
- High (>1.6) and low (<1.4) refractive index materials
  - Multimaterial 3D inkjet printing for Gradient-index lenses
  - Synthesis new building blocks

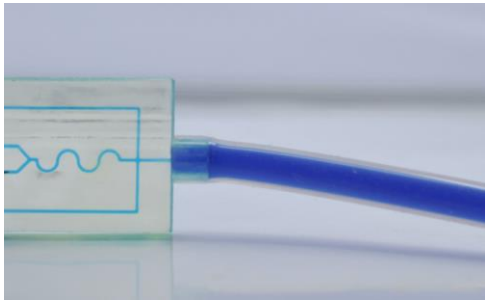


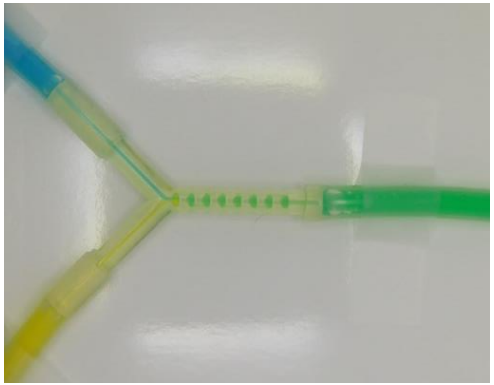
3D printing of (bio) microreactors





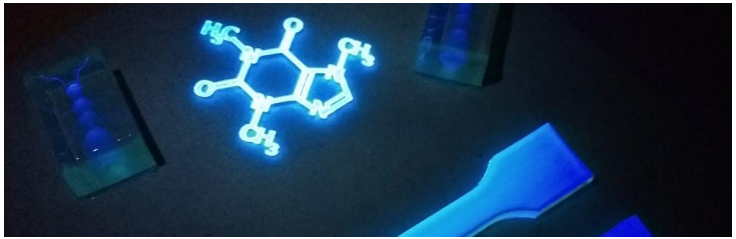
- High resolution 3D printing
  - XY resolution: 50 µm
  - Z-resolution: 3-30 µm
- Smooth surface morphology



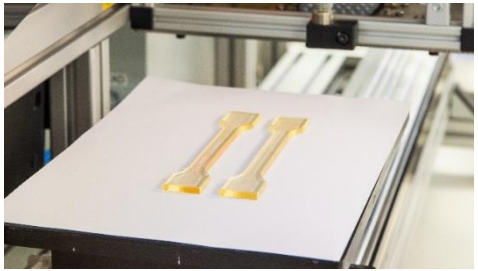


Multimaterial inkjet 3D printing

- Embedded functionality → **Inkjet grade nanodispersions**
  - Colors
  - Fluorescent
  - Ferromagnetic
  - Different refractive index
  - …

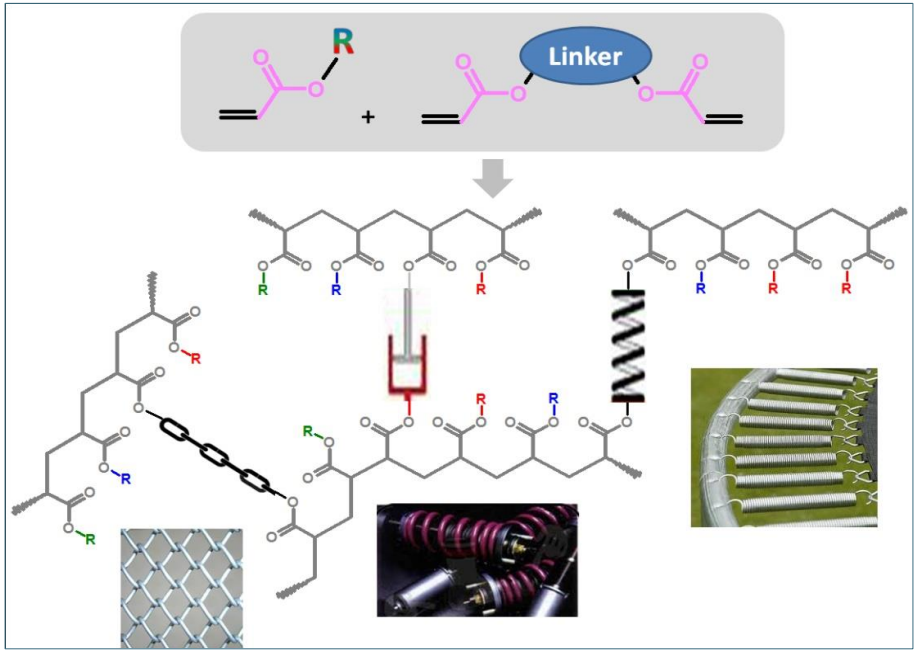


- Different mechanical properties
  - Hard/soft
  - High/low T_g
  - …

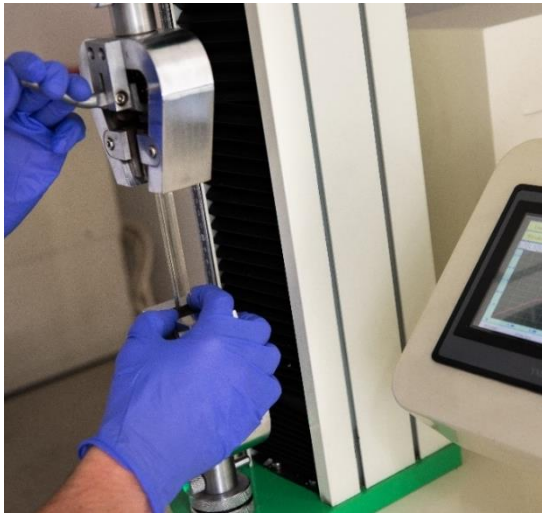


Mechanical properties

- Smart choice of building blocks



- Cross linking density
- Functionality side chain
- Functionality linker
- Intramolecular interactions



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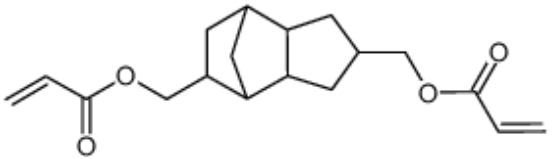
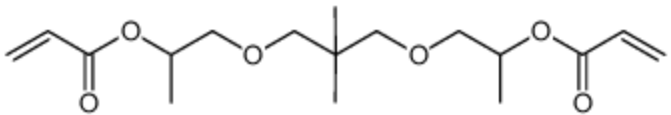
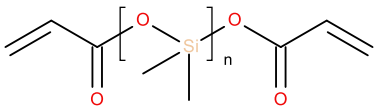
Mechanical properties

- Molecular design toolbox
  - Bifunctional crosslinkers







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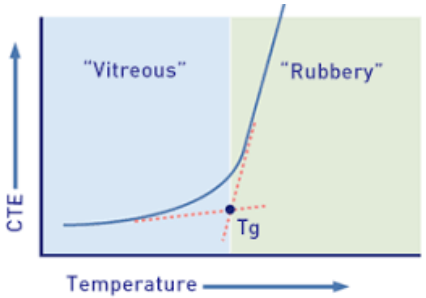
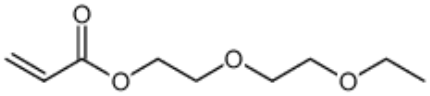
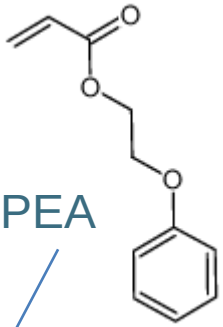
Mechanical properties

- Molecular design toolbox
  - Monofunctional monomers

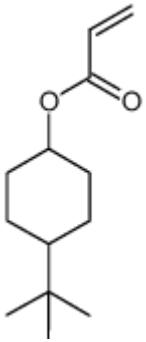




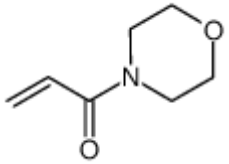
EOEOA



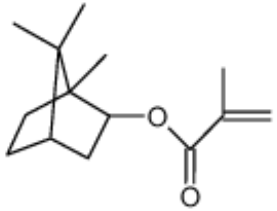
PEA



TBCH



ACMO



IBOMA

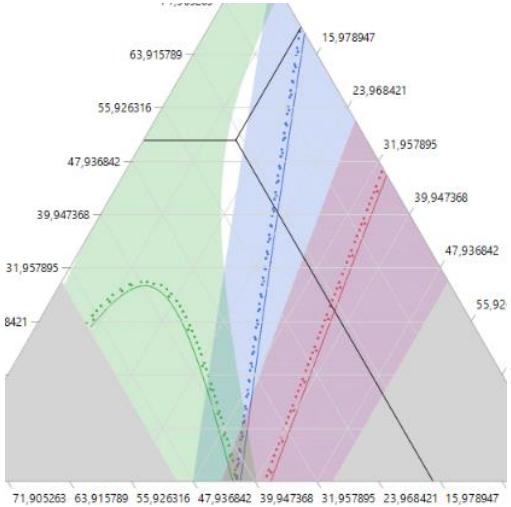
Glass transition temperature (T_g) – Heat deflection temperature (HDT)

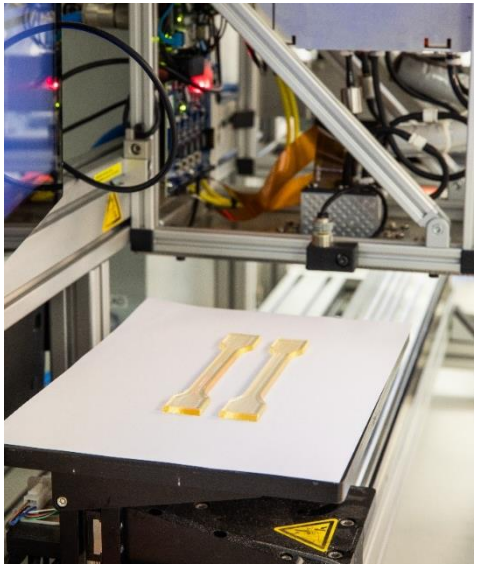
-50 0 50 100 150 °C

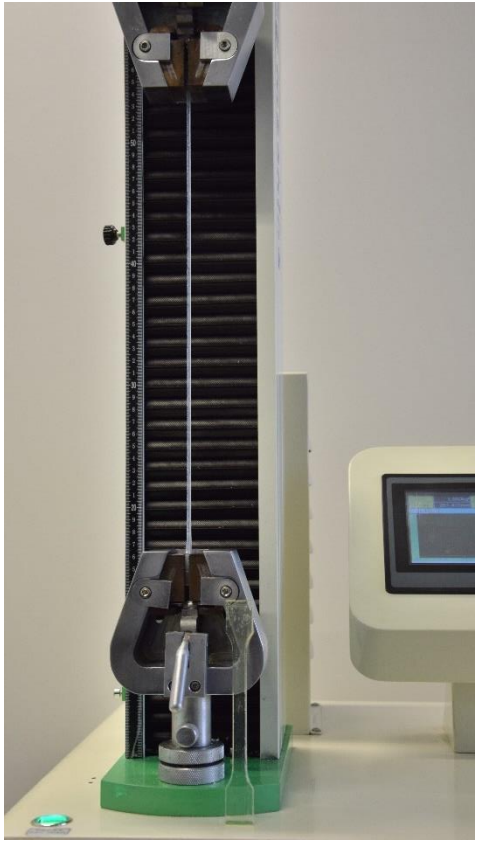
Mechanical properties

- Smart choice building blocks + DoE for optimized compromise between different physical properties

Mixture profiler







Thanks for your attention

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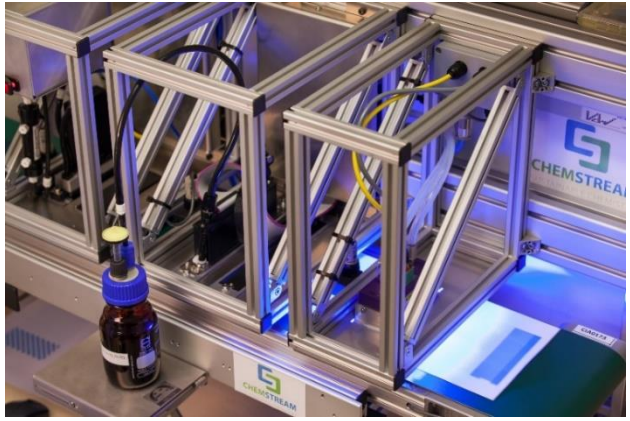

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