CHEMSTREAM
SUSTAINABLE CHEMISTRY

The added value of Inkjet in the 3D printing world

Dr. Els Mannekens
ChemStream

Chemstream: who are we?

- **Founded in April 2010**
- **Located near Antwerp – BE**
- **Staff profile (11 Chemists)**

  Organic chemistry, Rheology, Photochemistry, Biochemistry, Surface chemistry, Molecular Modeling,…
- **Lab-facilities (550 m²)**
  - Organic Synthesis
  - Chemical Formulation
  - Characterization
- **Prototype production facility**
  - Coatings: 250 L batches
  - Inkjet inks: 50 L batches













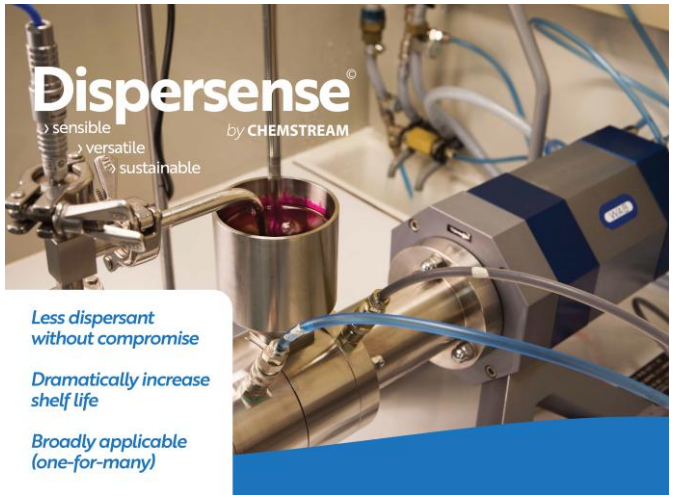

Chemstream: what do we do?

- **Aim:** translating requirements into chemical formulations with dedicated functionality
  => from design to prototyping
  = Customized product development
  via innovative contract research

- **Core activities:**

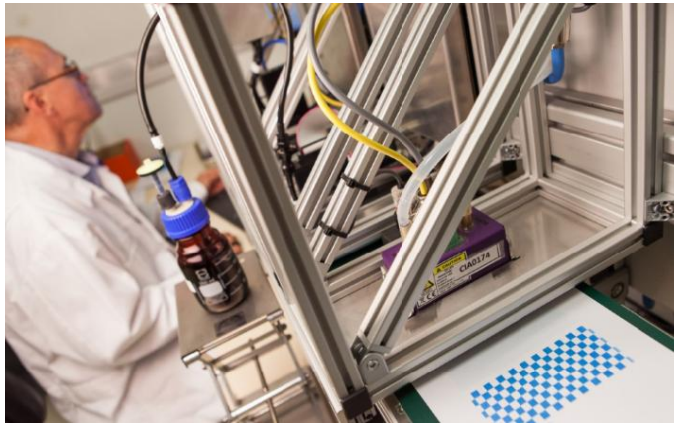
Design & Synthesis of (bio-based)polymers

Dispersing agents
Dispersense©



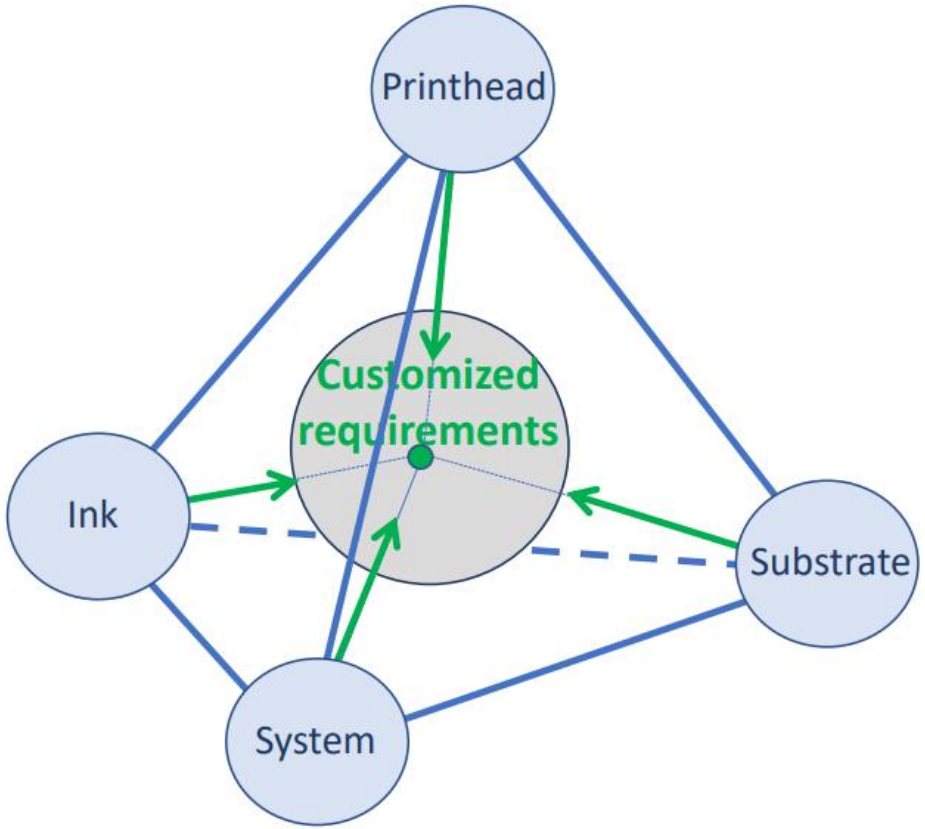
Stable nano-pigment dispersions

IJ ink formulations



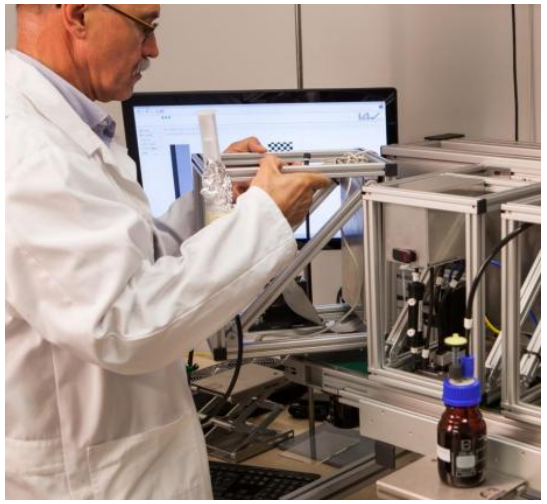
Chemstream's inkjet ink development

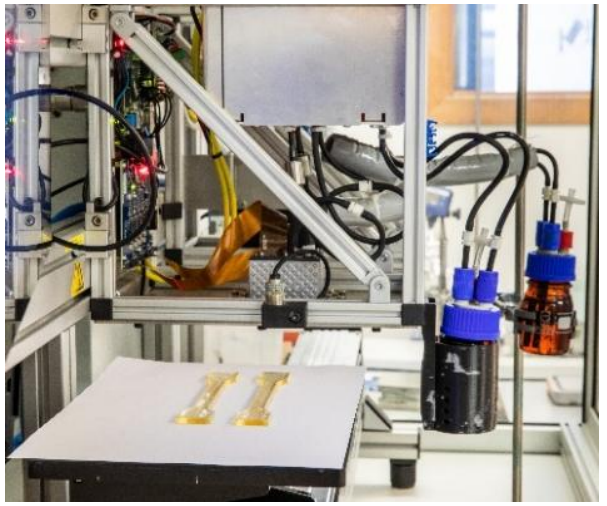
Inkjet ink development @ ChemStream via a System Integrated Approach



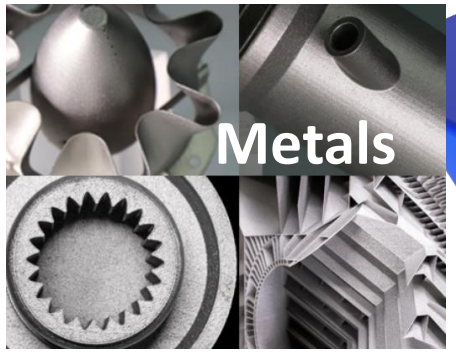
Modular Printing Units

- ❑ Exploration jetting performance
- ❑ Fast iterations of ink prototypes
- ❑ Replaceable printhead modules
- ❑ Mimic of an in-line printing process
- ❑ 2D and 3D IJ printing



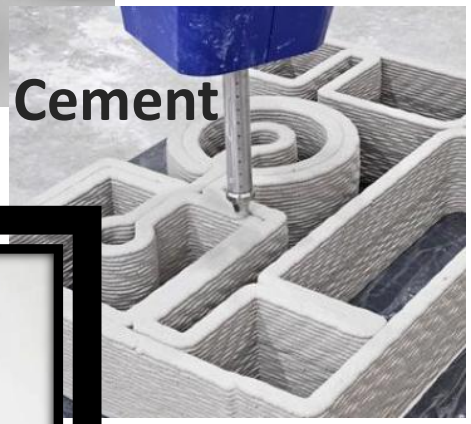


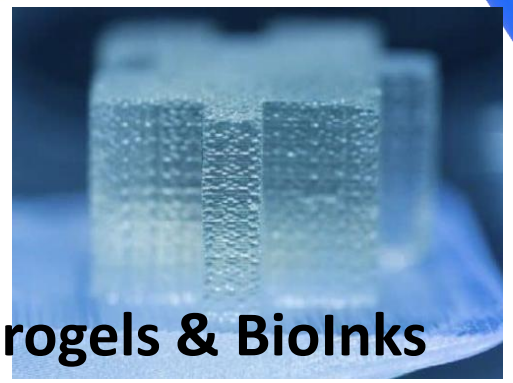
3D Printing world: Additive Manufacturing

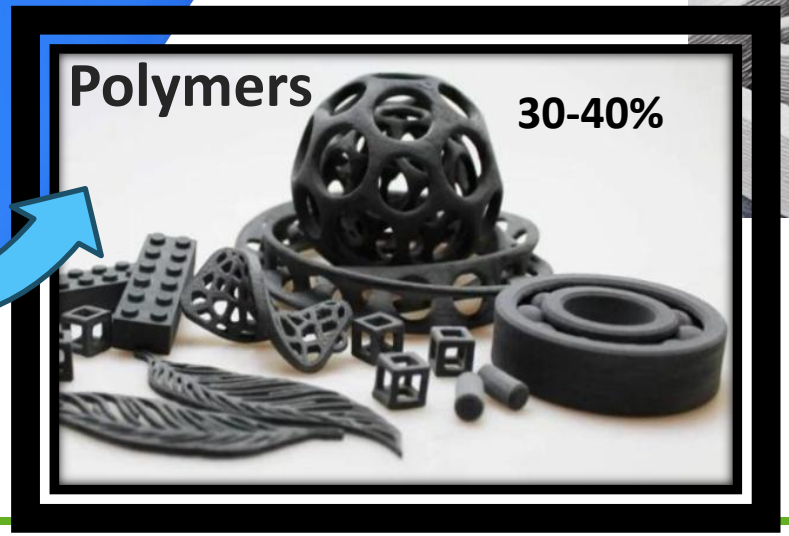


AM

Material based

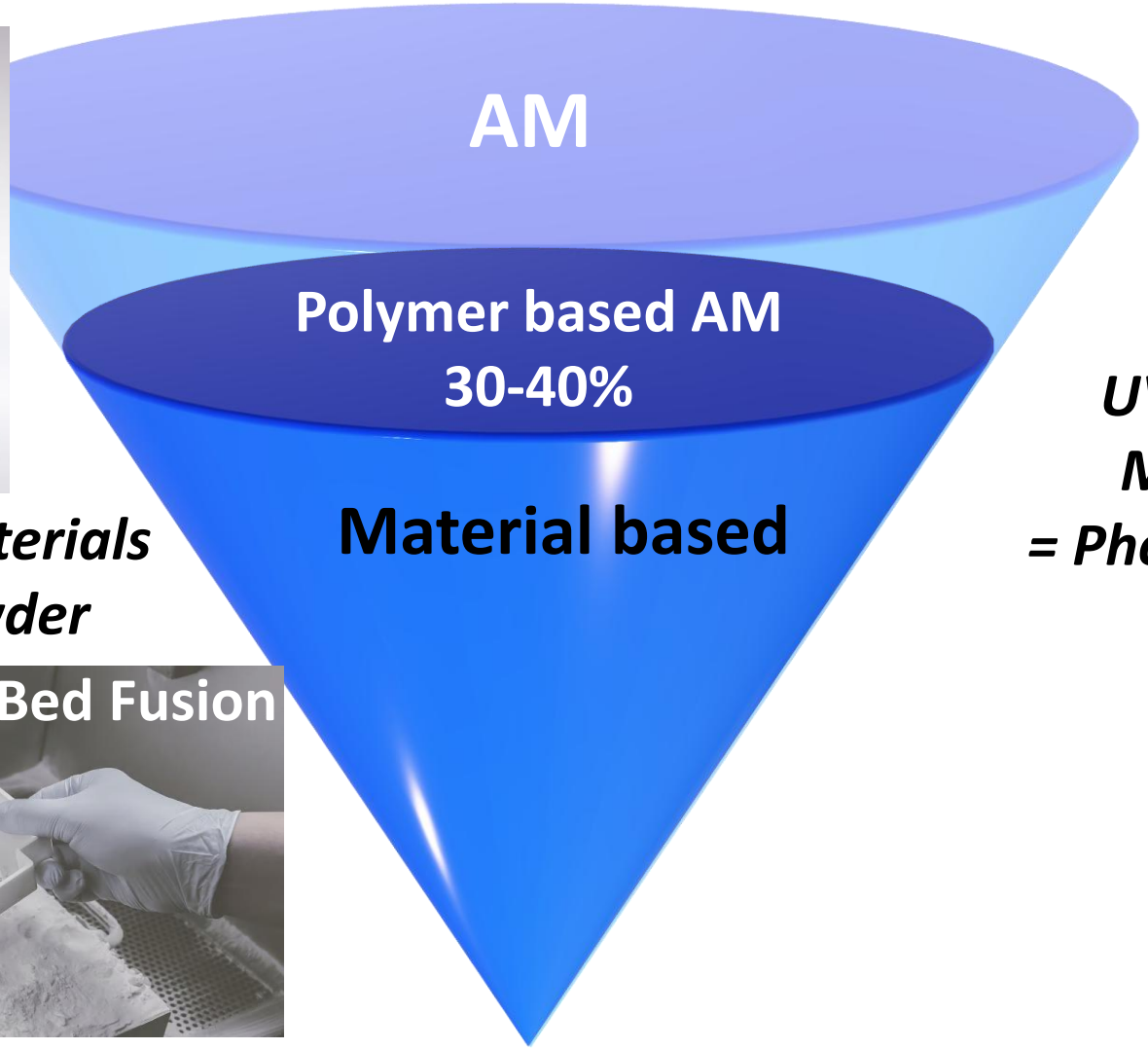




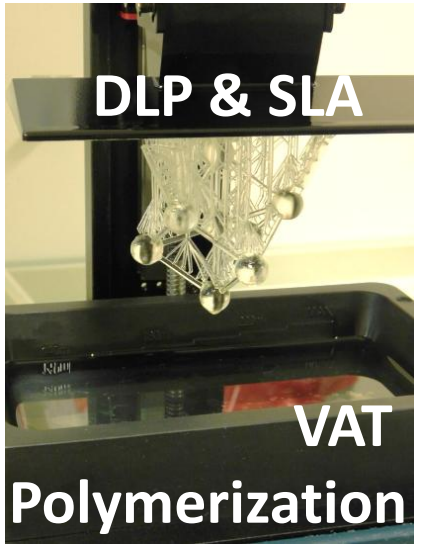


3D Printing world: Polymer based AM

Thermoplastic Materials
Filament or Powder



UV-curable
Materials
= Photopolymers



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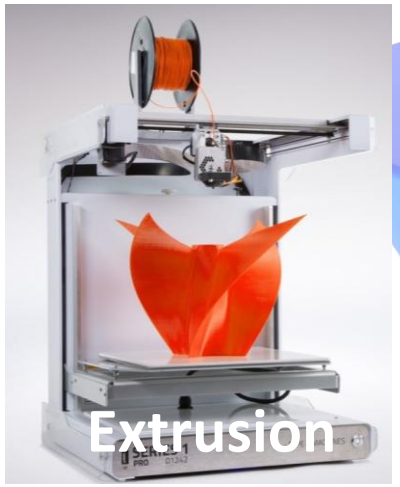

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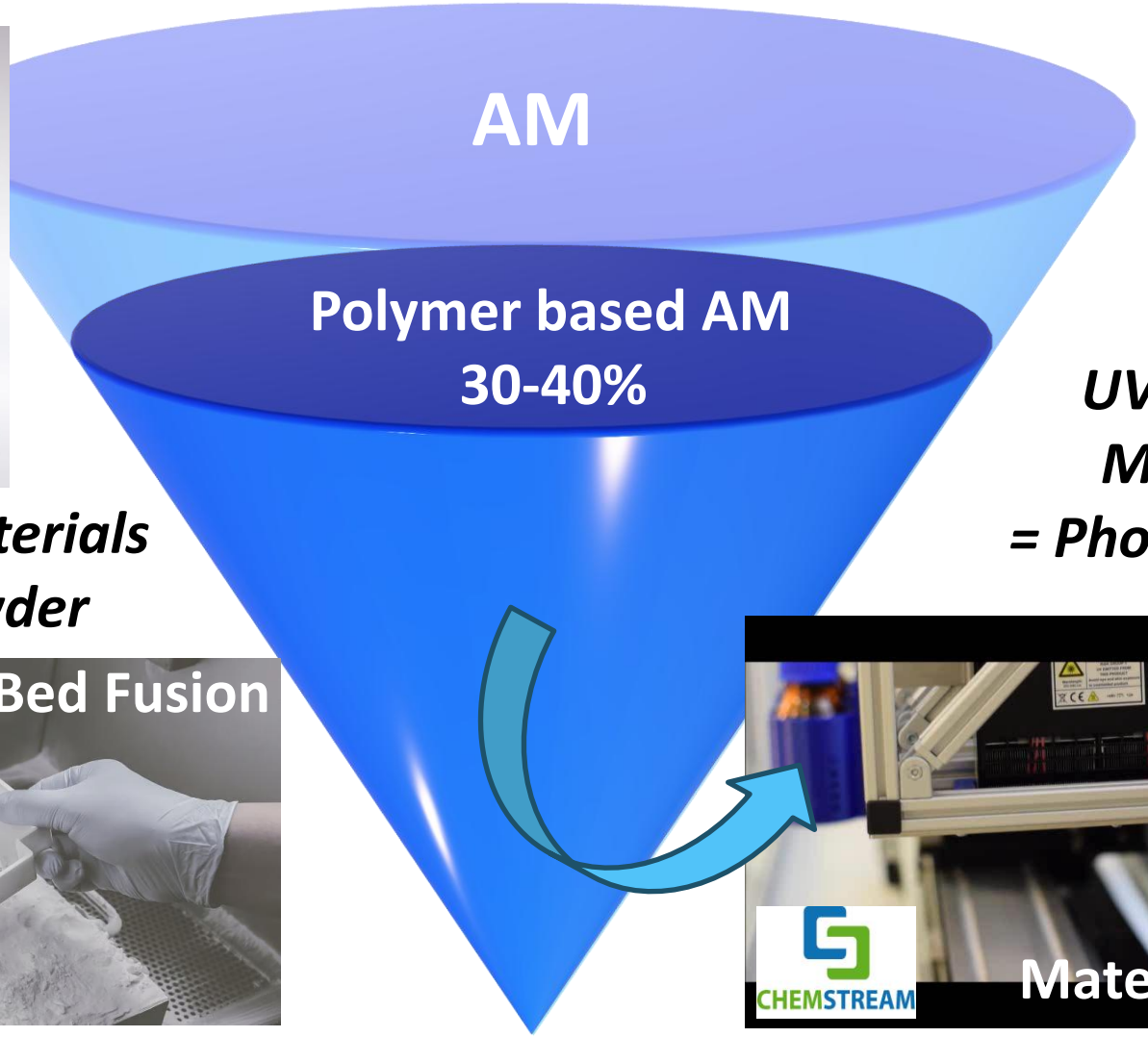

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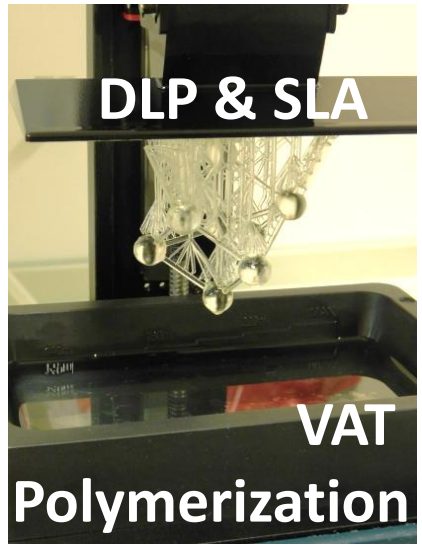
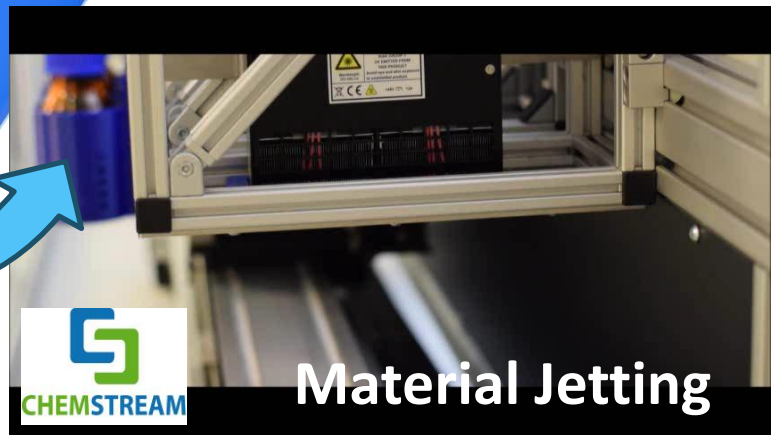
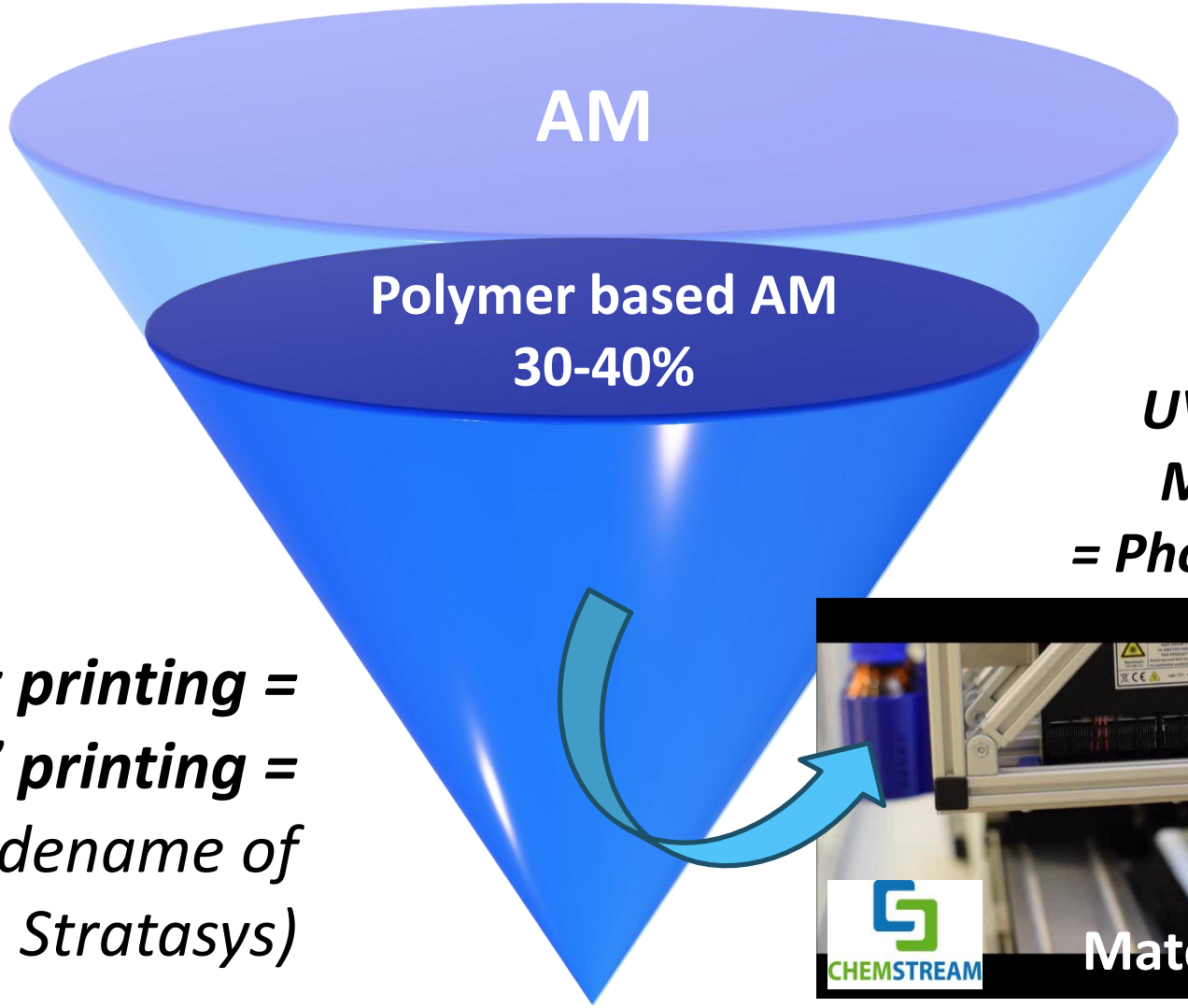


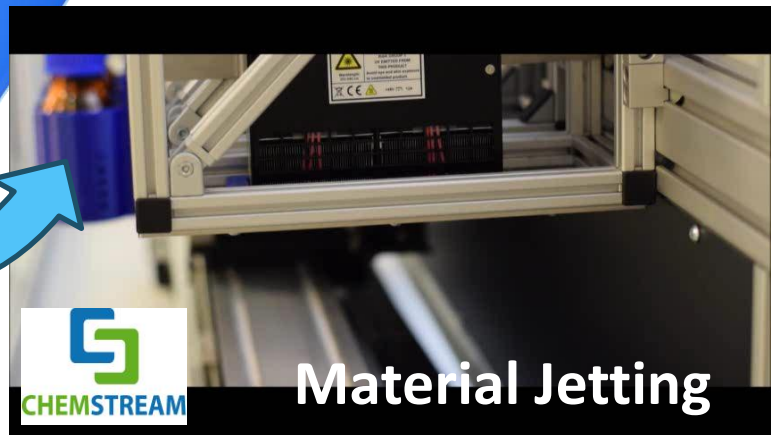


3D Printing world: Photopolymer based AM



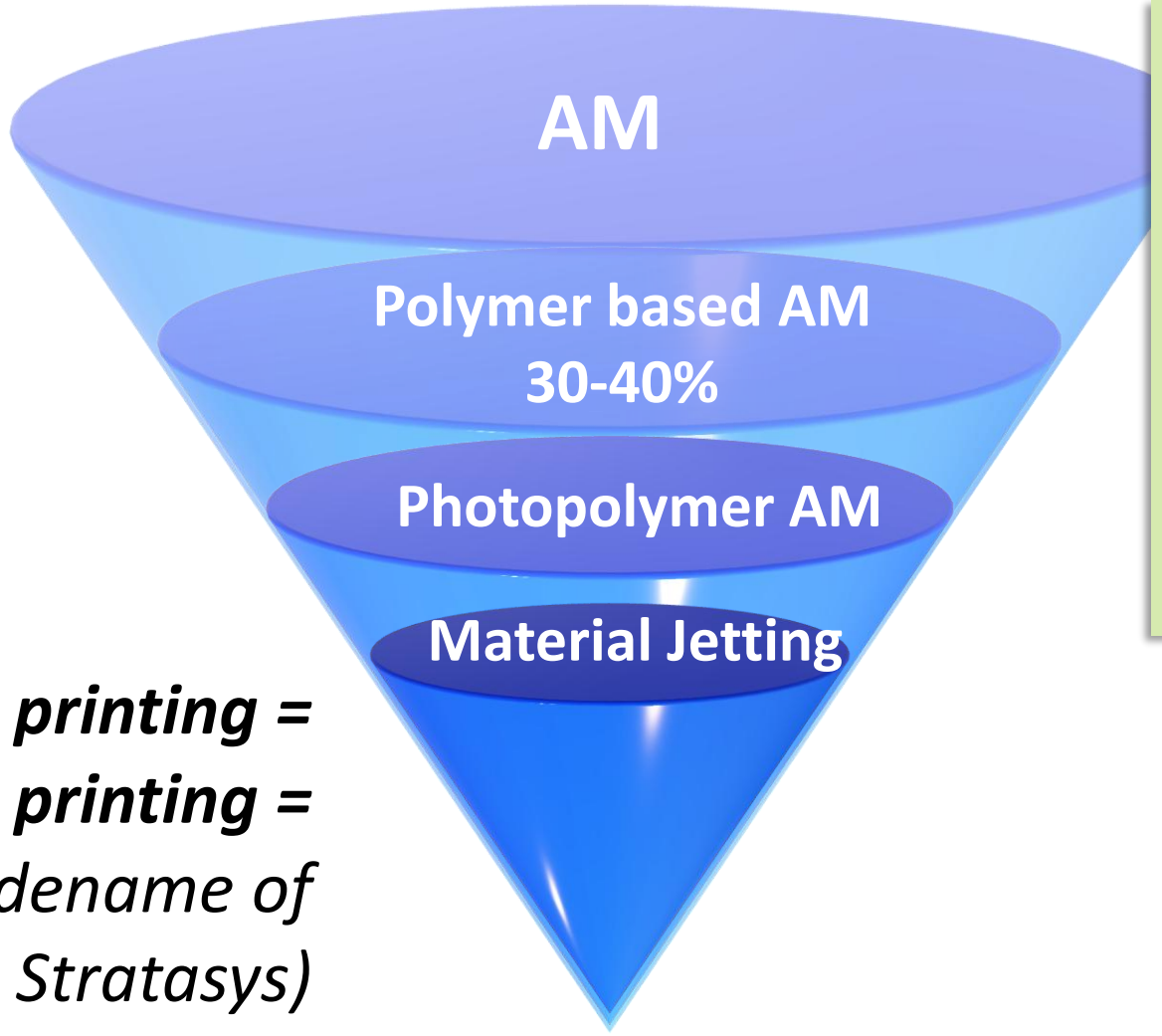
3D inkjet printing = "PolyJet" printing = *(tradename of Stratasys)*

UV-curable Materials = Photopolymers



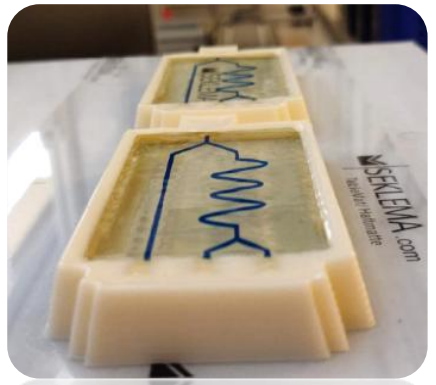
Yet a small segment but rapidly growing

Photopolymer based Material Jetting



3D inkjet printing =
"PolyJet" printing =
(tradename of Stratasys)

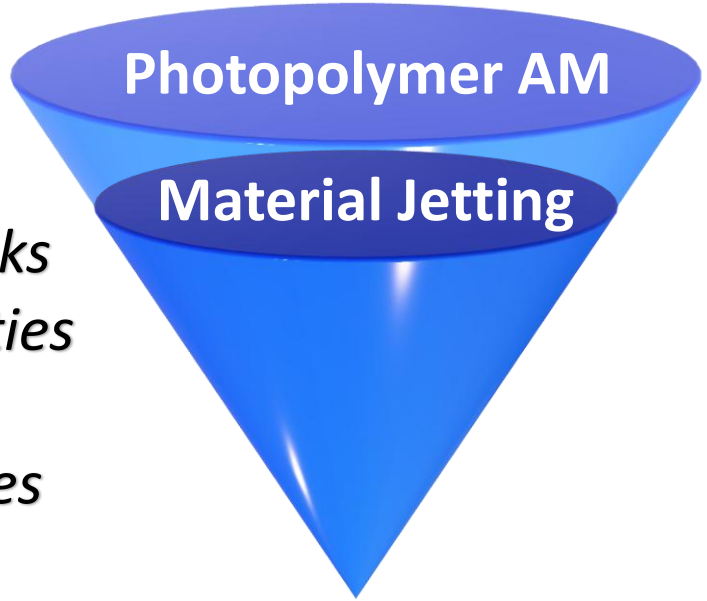
TYPICAL
Multi-material and/or multi-colour in 1 print job
&
High resolution in X,Y,Z



Commercial players:
- *Stratasys (PolyJet)*
- *3D Systems (MJP)*
- *Mimaki 3D printers*
- *Ricoh 3D*
- *NanoDimension*

Photopolymer based Material Jetting

3D developments in which ChemStream is currently involved



UV-curable Object inks

- *Δ physical properties*
- *Δ color*
- *Δ optical properties*
- *Biocompatibility*

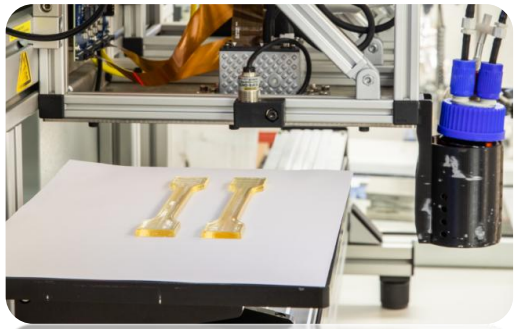
UV-curable Support ink

- *easily dissolving in water*

Biomedical

Dental

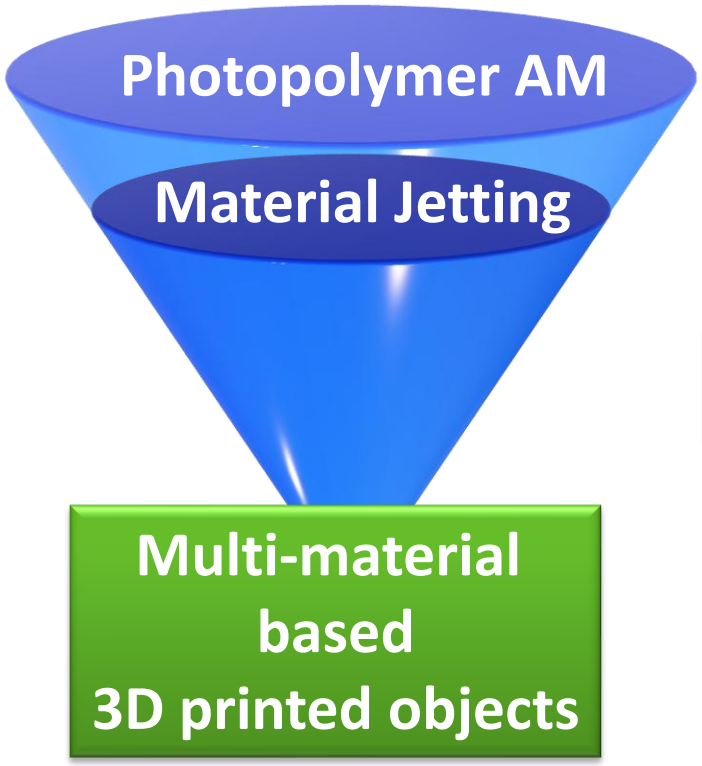
Optical



Automotive

Photopolymer based Material Jetting

Future developments: from 3D => 4D



Temperature

pH Moisture

STIMULI

Solvent Light

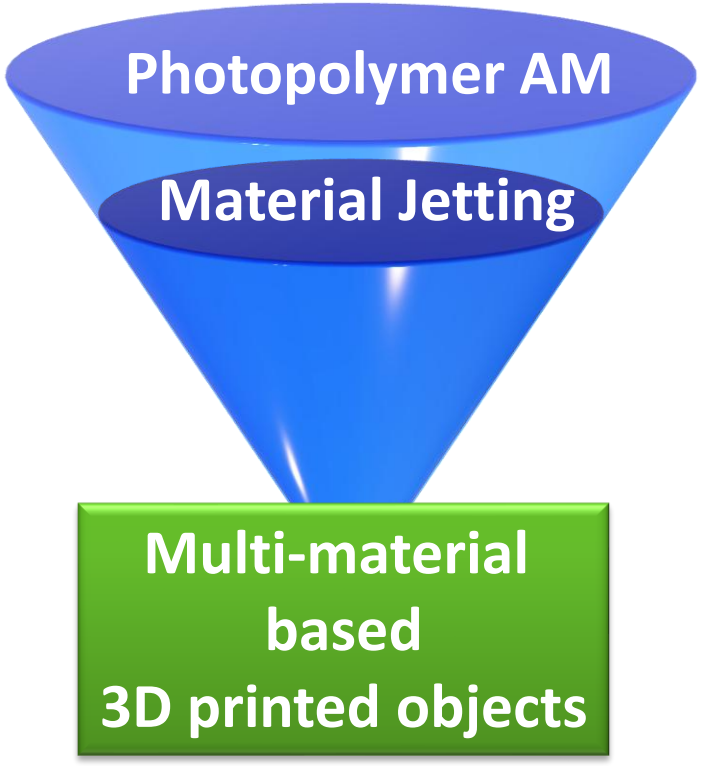
Pressure

- **Shape changes**
  - **Shrinkage**
  - **Expansion**
  - **Folding**
- **Color changes**
- **Release of ingredients**
- **Chemical reaction**

This requires multi-disciplinary R&D

Photopolymer based Material Jetting

Future developments: from 3D => 4D



Temperature

pH Moisture

STIMULI

Solvent Light

Pressure

Shape changes

Source: YouTube Video of Nicole Hone, Victoria University of Wellington, New Zealand

Photopolymer based Material Jetting

3D Print process:

3D Model

Computer Aided Design (CAD) software or scan

=> CAD file

Additive Manufacturing File (AMF)

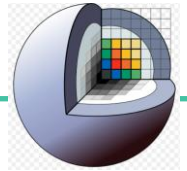
= STL/3MF-file

describes the surface geometries of the object

Slicer Program

To create slices in 2D layers

=> to be 'understood' by a 3D printer (printheads)



Printing

+ UV-curing

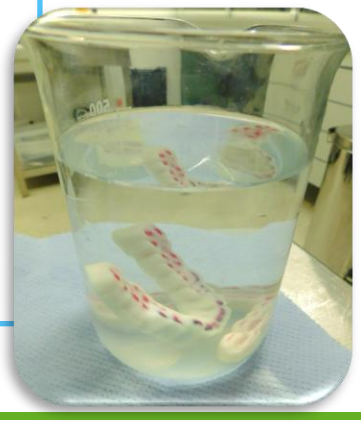
Layer by layer

Post-Processing

* Removal of support ink

* Post-cure

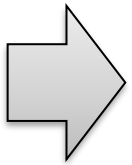
* Polishing if needed



Photopolymer based Material Jetting

3D Inkjet printing

- Multiple printheads (multi-material)
- Low viscosity range (10-60 cP)
- High precision
  (up to 10 μm layer thickness)

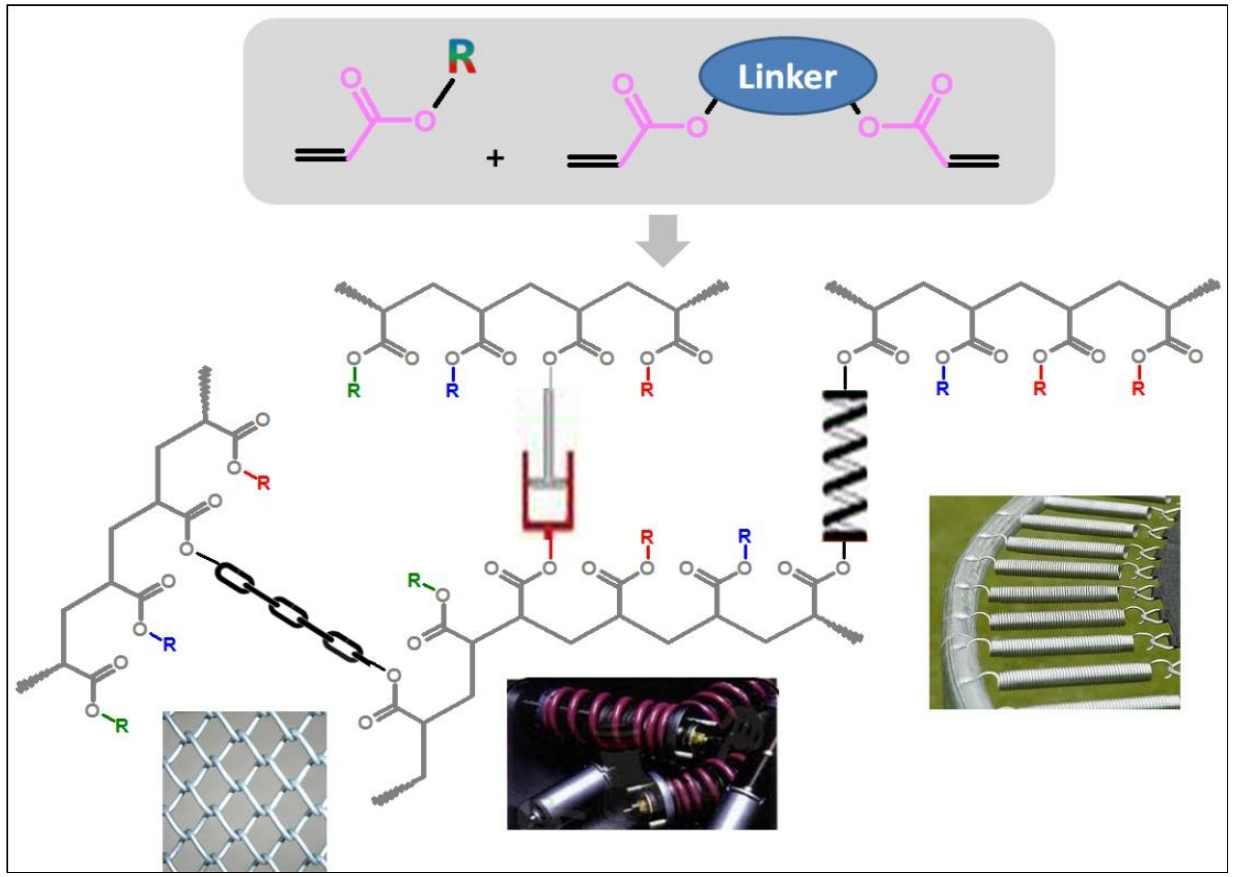


Challenges

?

Photopolymer based Material Jetting

Smart choice of ink building blocks



Challenges

- Limited materials
- Limited functionalities
- Limited mechanical strength
  - ❑ Brittleness, shrinkage & internal stress
- Biocompatibility
- Ageing
  - ❑ Sensitive to UV light & heat

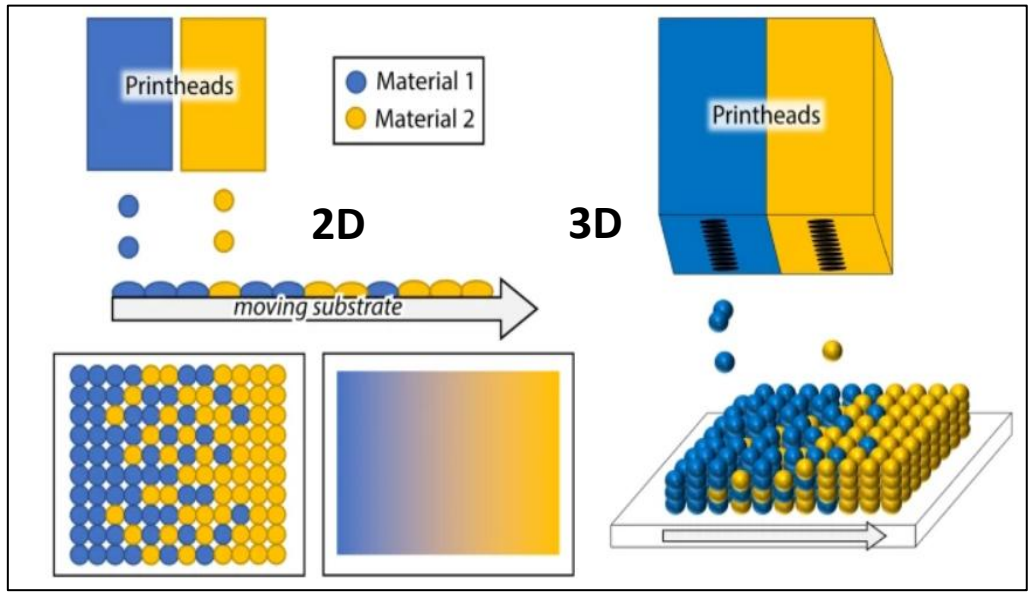
PHTHALATE FREE

TPO FREE

Need for printheads that can handle higher viscsous and viscoelastic functional fluids with sufficient accuracy

Photopolymer based Material Jetting

Multi-material build-up strategy



Eur. Phys. J. Spec. Top. (2025) 234:3077-3087
https://doi.org/10.1140/epjs/s1173-024-01396-9

iPrint et al

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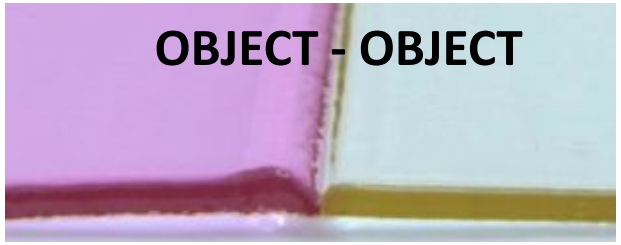
- Biocompatibility
- Ageing
  - ❑ Sensitive to UV light & heat
- **Color matching software & multi-material build-up strategy (voxels)**

Photopolymer based Material Jetting

Ink-ink interactions



Internal stress

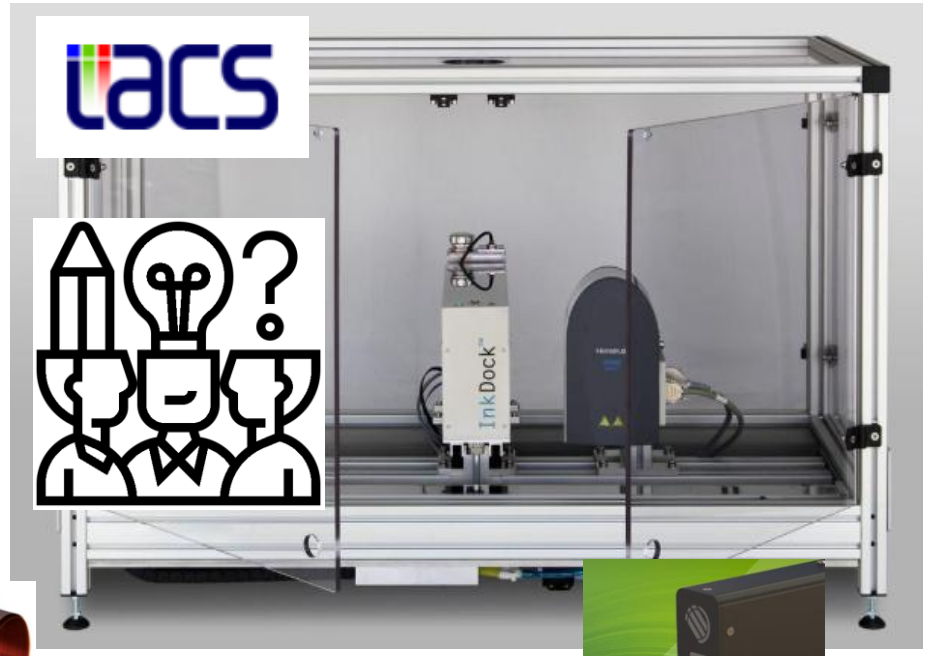
Roller/leveler – in-loop corrections

Challenges

- Limited materials
- Limited functionalities
- Limited mechanical strength
  - ❑ Brittleness, shrinkage & internal stress
- Biocompatibility
- Ageing
  - ❑ Sensitive to UV light & heat
- Color matching software & multi-material build-up strategy (voxels)
- **Geometrical accuracy depends on the interplay between**:
  - ❑ **ink properties & ink-ink interactions**
  - ❑ **UV-curing strategy**
  - ❑ **drop placement accuracy & strategy**

Photopolymer based Material Jetting

Team work! ➡ See demonstrator!



IST INTECH
UV LED CURING SPECIALISTS

Challenges

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- Limited mechanical strength
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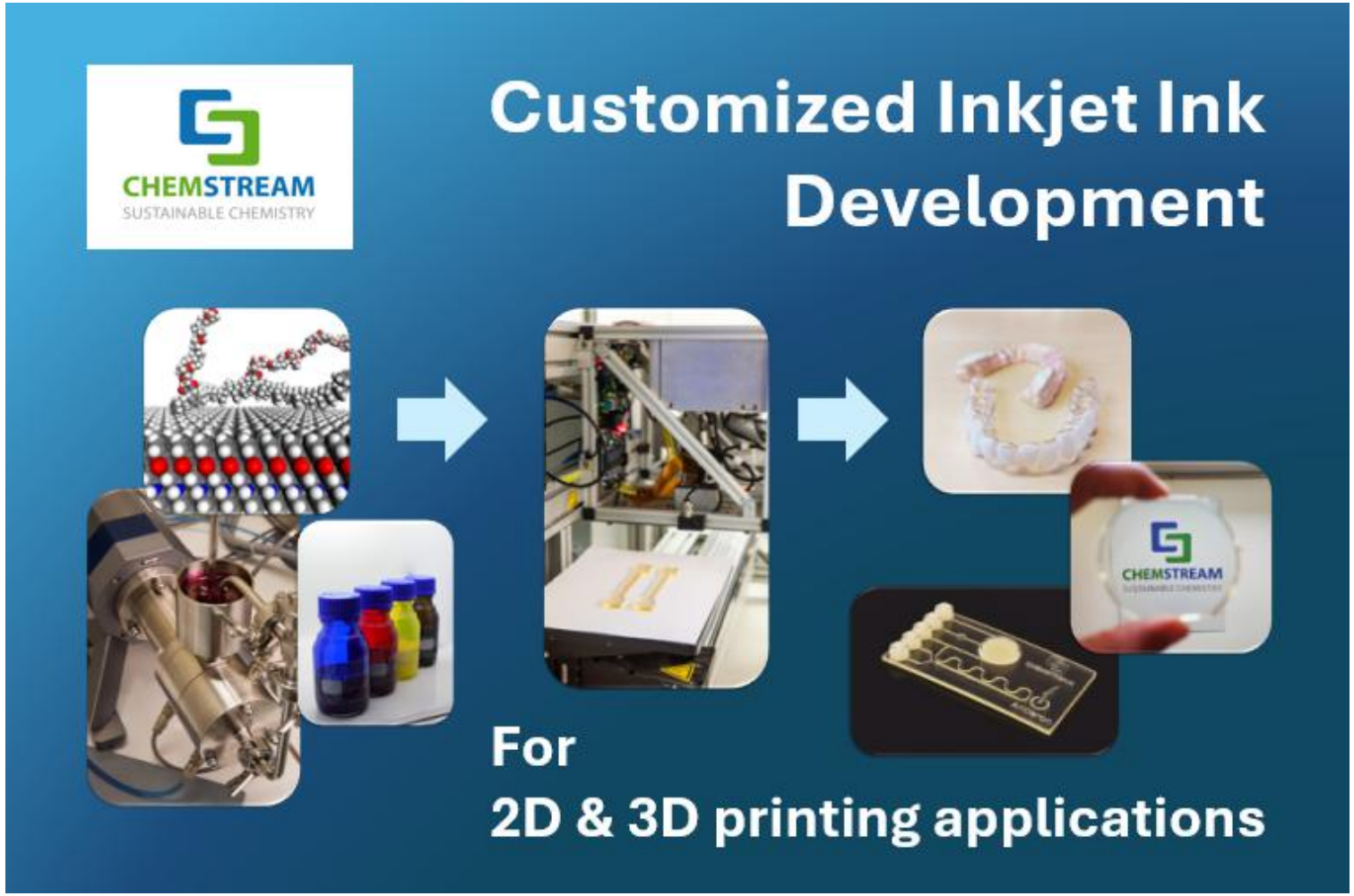
ChemStream support

- Ink Design
- Functionality
- Ink stability
- Wetting
- Adhesion



- Compatibility
- Jettability
- Printing & Curing strategy
- Post-cure
- Extractables