CHEMSTREAM
SUSTAINABLE CHEMISTRY

INDUSTRIALPRINTINTEGRATION

The challenges of IJ printing in Additive Manufacturing

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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?

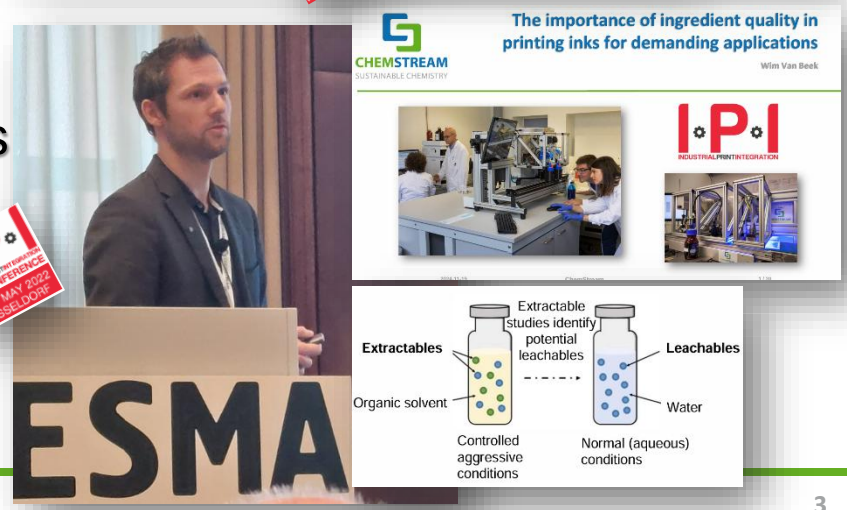
- **Aim:** translating requirements into chemical formulations with dedicated functionality
  => from design to prototyping
  = Customized product development
  Via innovative contract research

- **Core activities:**
  - Design & Synthesis of (bio-based)polymers

Dispersing agents
Dispersense©

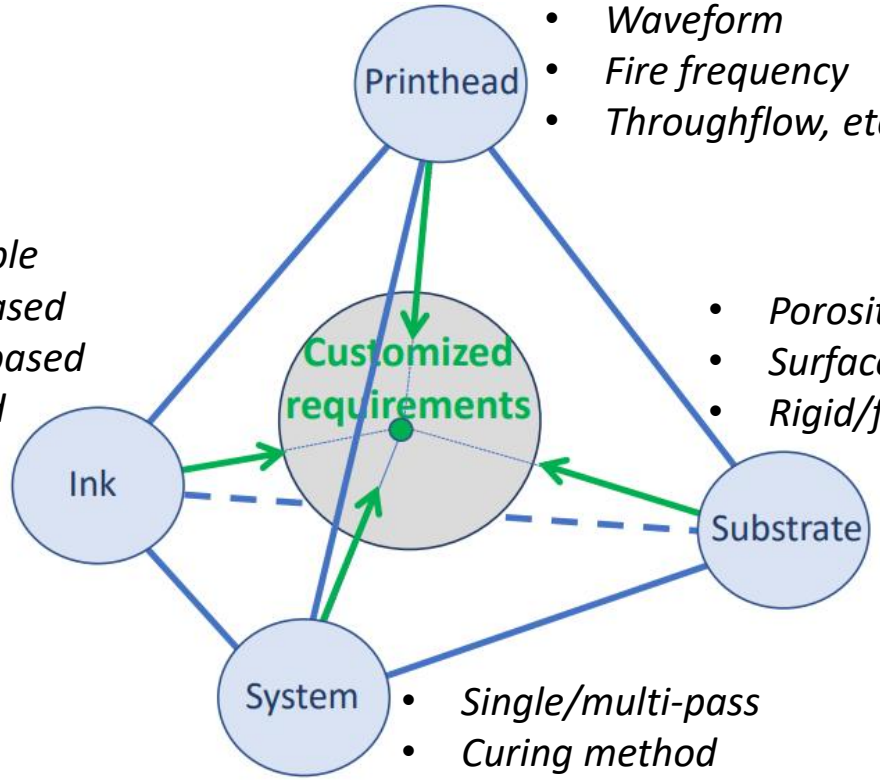
Stable nano-pigment dispersions

IJ ink formulations



Chemstream's inkjet ink development

Inkjet ink development @ ChemStream via a System Integrated Approach



- *Waveform*
- *Fire frequency*
- *Throughflow, etc.*

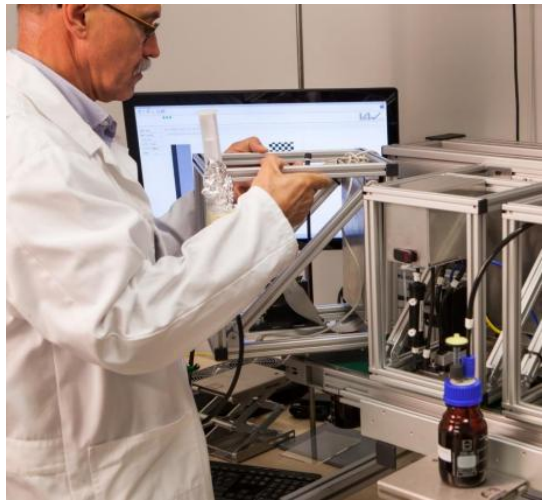
- *UV-curable*
- *Water based*
- *Solvent based*
- *Oil based*
- *Hotmelt*

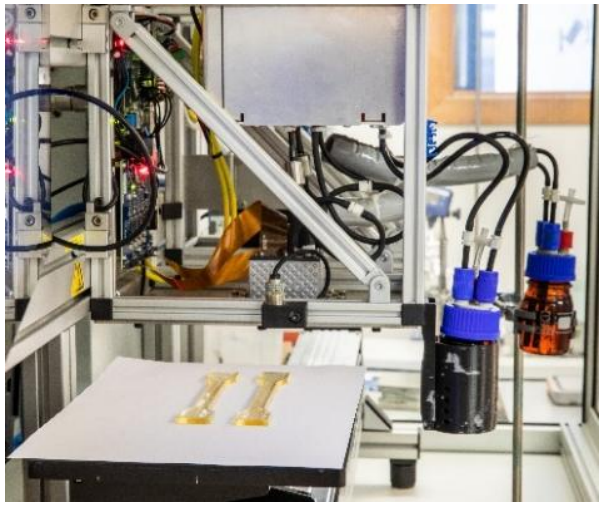
- *Porosity*
- *Surface energy*
- *Rigid/flexible, etc.*

- *Single/multi-pass*
- *Curing method*
- *Print speed, etc.*

Modular Printing Units

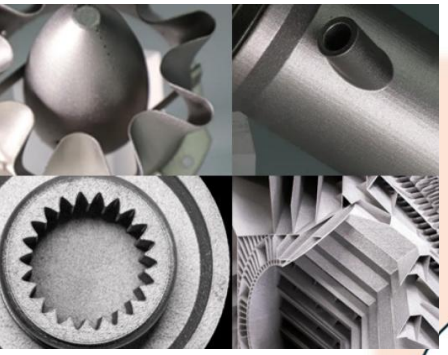
- ❑ Mimic of an in-line printing process
- ❑ Exploration jetting performance
- ❑ Fast iterations of ink prototypes
- ❑ Replaceable printhead modules
- ❑ 2D and 3D IJ printing

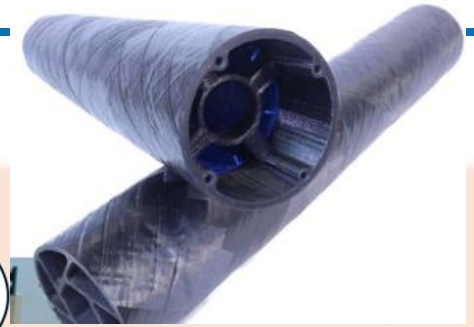


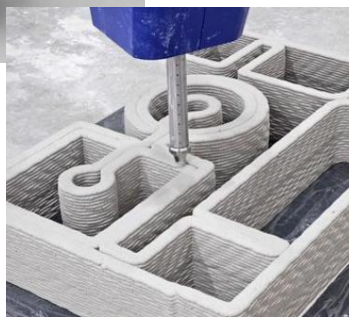


AM technologies = 3D printing

Material based







Composites AM

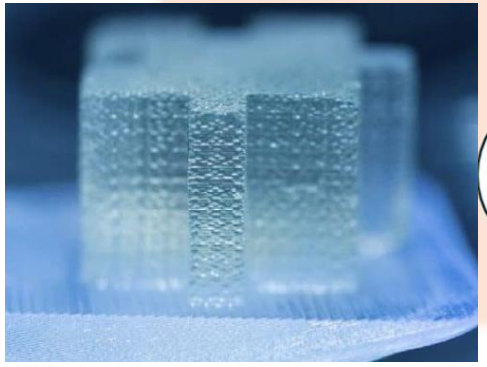
Metal AM

Ceramics & Cement AM

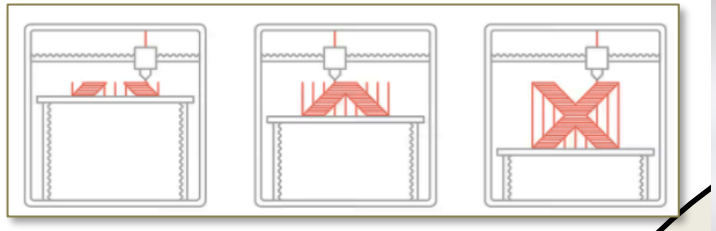
Additive Manufacturing Technologies

Hydrogels & Bioinks AM

Polymer AM



Polymer based AM



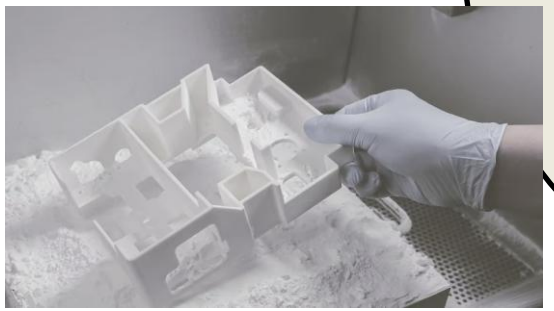
Thermoplastic Filament
(PLA, ABS, PETG, TPU,…)

EXTRUSION

VAT (SLA/DLP)

Photopolymer resin in a VAT

Polymer AM

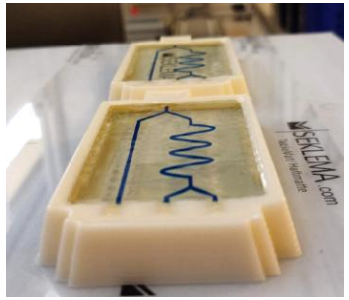


POWDER BED FUSION

Thermoplastic Powder
(PP, TPU, Nylon, PA,…)
+ melting/sintering

MATERIAL JETTING

Photopolymer resins
= **UV-inkjet inks**



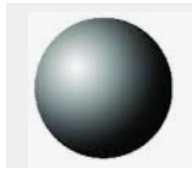
Photopolymer based AM

3D Print process:

3D Model

Computer Aided Design (CAD) software or scan

=> CAD file



Additive Manufacturing File (AMF)

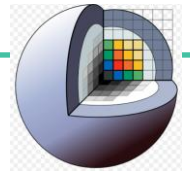
= STL/3MF-file

describes the surface geometries of the object

Slicer Program

To create slices in 2D layers

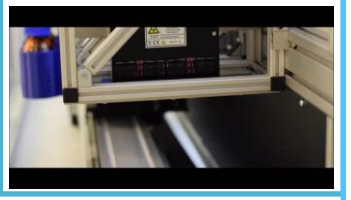
=> to be 'understood' by a 3D printer (printheads)



Printing

+ UV-curing

Layer by layer



Post-Processing

* Removal of support ink/structures

* Post-cure

* Polishing if needed

Photopolymer based AM

VAT polymerizaton (SLA/DLP)

- 1 VAT = single material
- Broad viscosity range (100-10.000 cP)
- More material versatility & physical properties
- Easier to achieve biocompatibility
- High precision (up to 10 μm layer thickness)

Material Jetting (3D IJ printing)

- Multiple printheads = multi-material
- Low viscosity range (10-60 cP)
- Limited materials & mechanical strength
- More challenging to achieve biocompatibility
- High precision (up to 10 μm layer thickness)

Innovations in the future

- Multi-material VAT photopolymerisation
- Ageing proof

- Advanced printheads for higher visco
- More materials and functionality
- Ageing proof
- Better biocompatibility
- Steady quality and reproducibility

Material Jetting @ ChemStream

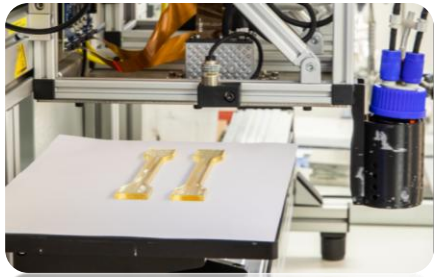
Advanced applications:

Biomedical

Dental

Optical

Automotive



Key requirements:

- Print resolution
- Biocompatibility
- Removable support ink

- Physical properties
- Biocompatibility
- Multiple object inks
- Functionalisation

- Transparancy
- Refractive index
- Non-yellowing
- Smoothness

- Physical properties
- Ageing
- Colour

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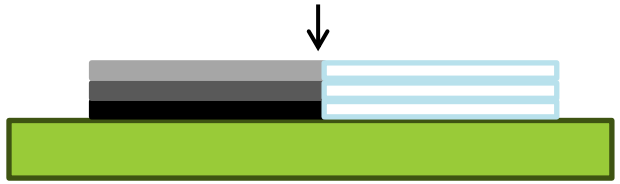
Challenges to tackle:

Ink layer build-up quality

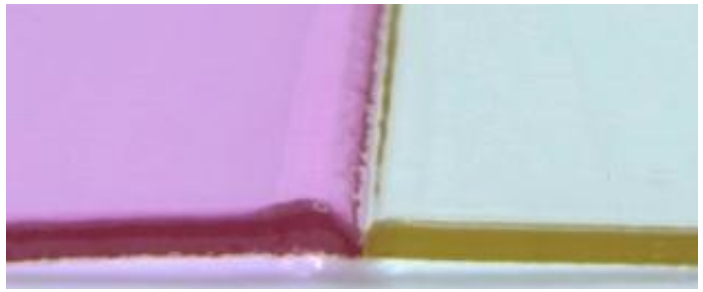
- Ink-ink compatibility + interface effects



Straight & smooth walls + surface evenness

OBJECT - SUPPORT

OBJECT - OBJECT



- Layer leveling rollers & in-loop correction

Flat & even surface & less internal tension + reproducible and consistent object geometries

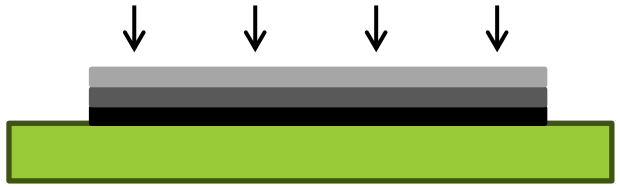
**courtesy of ALTANA Cubic Ink*

Material Jetting @ ChemStream

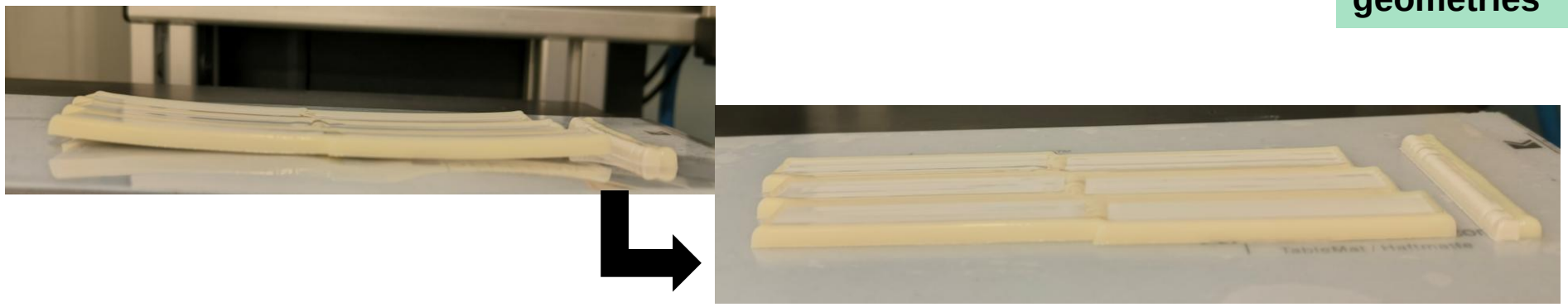
Challenges to tackle:

Curing efficiency and internal stress

- Shrinkage & risk of over-curing => brittleness and geometric deformation of printed parts



Flat objects & correct, reproducible geometries



- Proper curing depth, layer-by-layer => inter-layer bonding and optimized gel point

Optimized material performance + less migratables & geometrical accuracy

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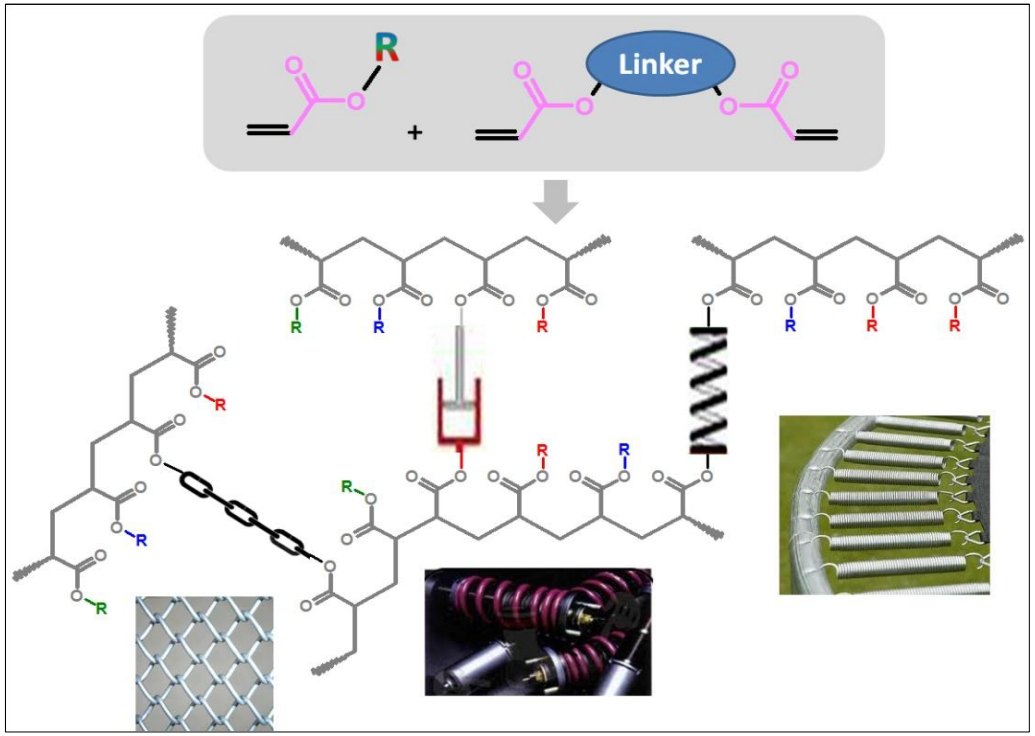
Challenges to tackle:

Material properties improvements

- Limited material properties & biocompatibility
  => new ink developments
  and advanced printheads



Smart choice of building blocks

Expansion of applications & functionalities + avoiding migration of uncured hazardous substances

PHTHALATE FREE

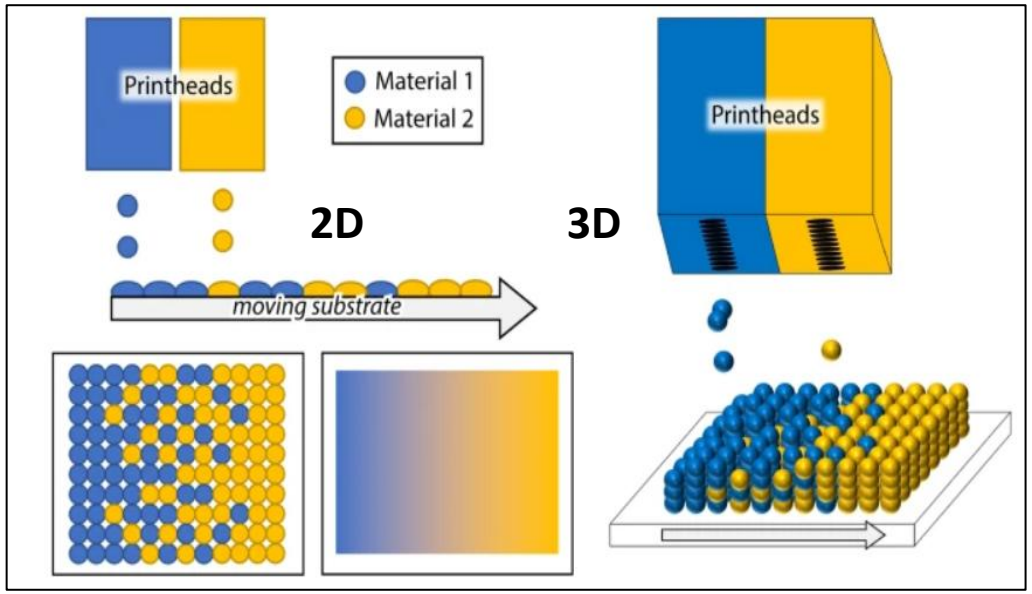
TPO FREE

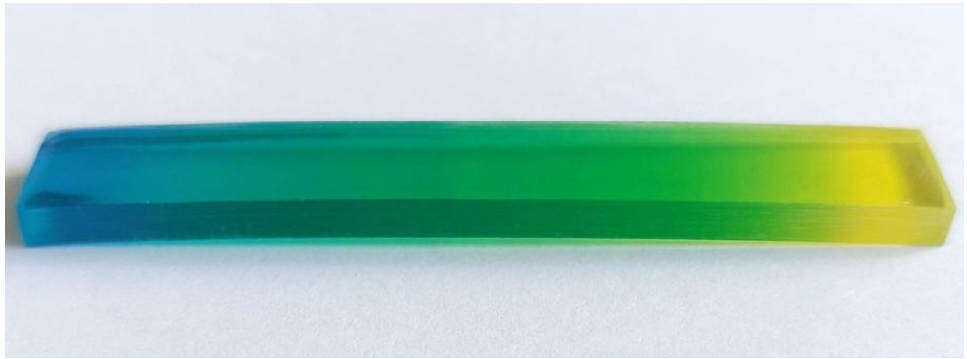
Material Jetting @ ChemStream

Challenges to tackle:

Multi-material build-up strategy

- Clever software and ink-deposition scheme to handle the multi-material build up (voxel-wise build-up, graded color scheme, physical properties range,…)





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

3D inkjet printing

How can ChemStream support the development of such a process?

- **Smart choice of UV-curable building blocks** to obtain the object specifications
- Fine-tuning of:
  - the inks for specific **printhead compatibility**
  - the **ink-spreading characteristics** and **ink-ink interactions**
  - the **colour** of the inks (< pigment dispersions)
- Design of a **compatible support ink**
- Exploration of the **ink deposition process** using in-house modular printing units
- Optimization of the **post-curing procedure** / ink
- **Analytical support** in the determination of **extractables**

Addendum

Example of a nice 3D-printing application:

VAT photopolymerisation used for the manufacturing of a customized dental floss apparatus, sold by Proclaim

www.proclaimhealth.com

Custom-Jet Oral Health System