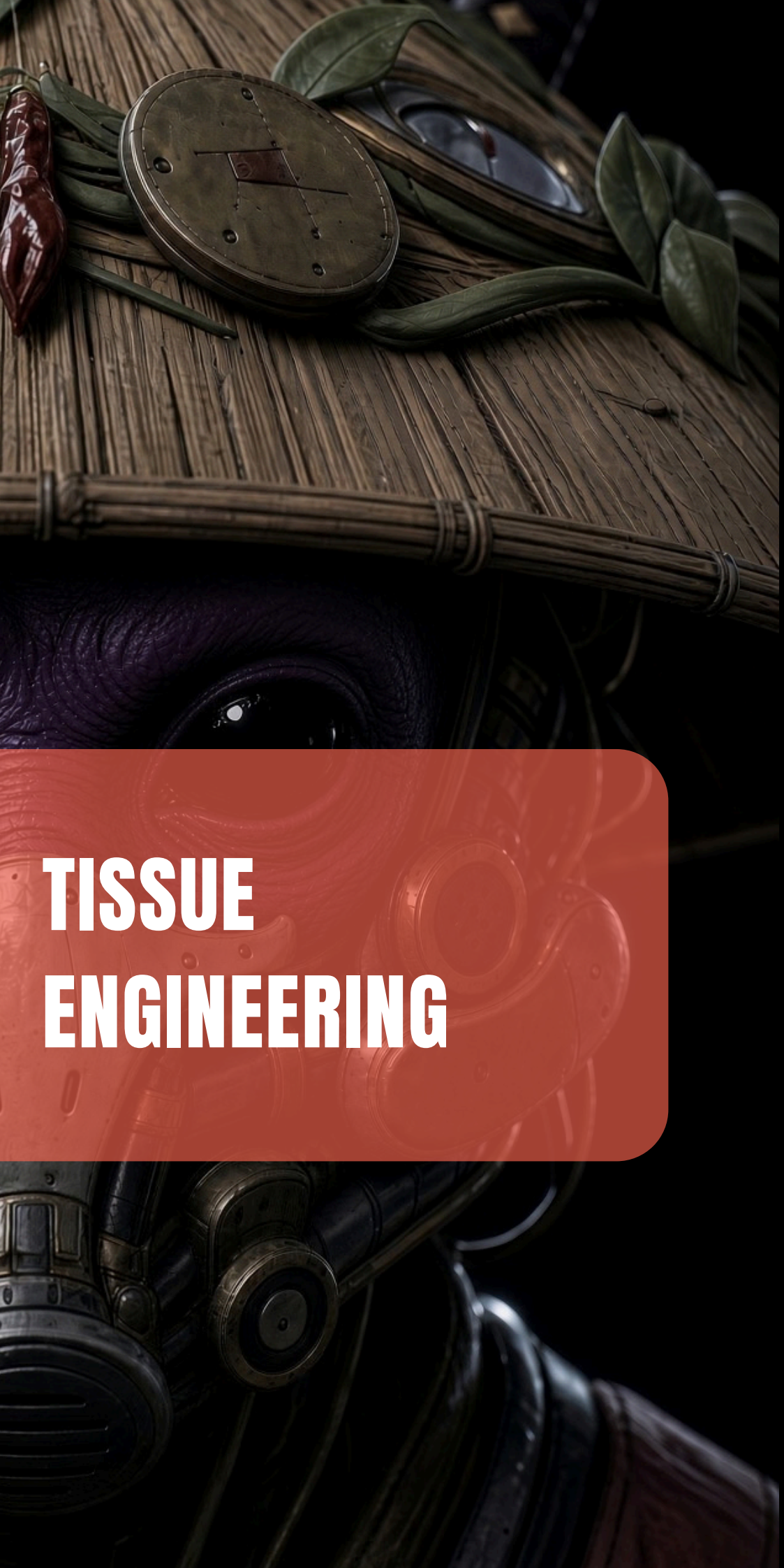


Makby

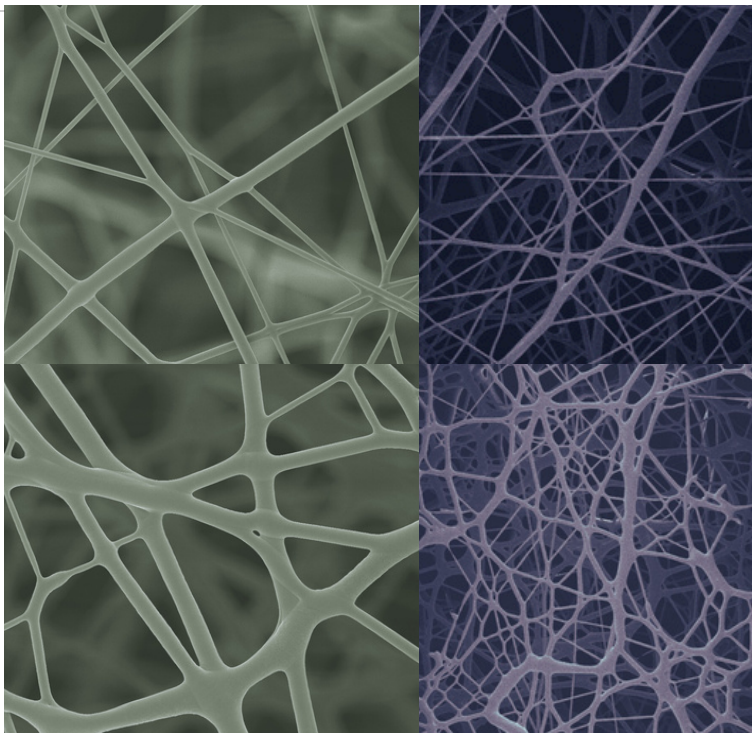
TISSUE ENGINEERING

Oct 2026

Makby

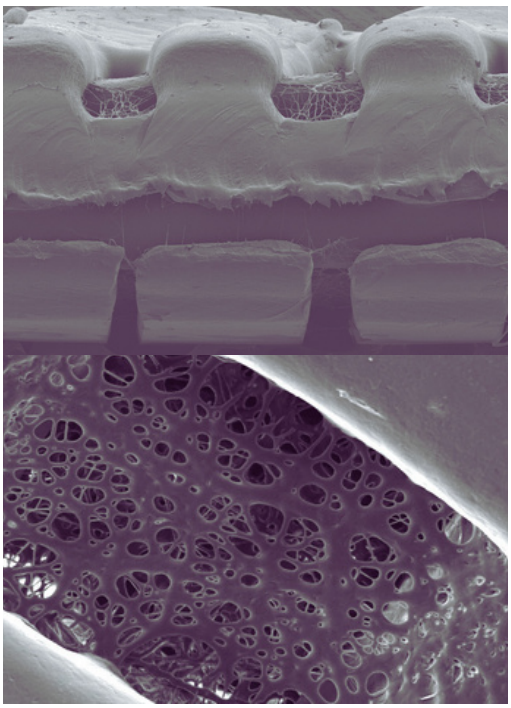
OUR APPROACH

Focuses on advanced material characterization and understanding cellular responses to materials



By integrating advanced technologies —including multimodal bioprinting, state-of-the-art AI modeling software, and advanced materials—**MAKBY** enables the creation of complex, multi-material porous scaffolds with highly sophisticated architectures and geometries.

Moreover, **MAKBY** supports the validation of novel biomaterials, helping to assess and enhance their performance in bioprinting, and facilitating their translation toward clinical applications.



This approach enables high-resolution fabrication of complex geometries while delivering excellent material performance and advanced bioprinting capabilities, making **MAKBY** the ideal partner from design to fabrication of complex tissue-engineered models.

CATALOGUE

PRODUCTS

BIOPRINTERS

- IsoMakby
- PicoMakby
- DomoMakby

SOFTWARE

- Makby Studio

BIOMATERIALS

- PoloxInk
- GelMA Ultra
- SUMC Ink
- SVPC Ink
- SFCVC ink
- TRE Hydrogel
- SGM Hydrogel
- 4D-HTOR Hydrogel

PLATFORMS

- OmniEnzyme
- CapilPro

SERVICES

BIOMATERIALS & SCAFFOLDS

- Material Lab
- ScaffoldDynamics
- Lasing MicroCraft
- Pre-Clinical Biomaterials

MAKBY

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BIOPRINTERS

PRODUCTS	CHARACTERISTCS
IsoMakby	Two-Head Thermoregulated Extrusion Bioprinter
PicoMakby	High-resolution Masked Stereolithography Bioprinter
DomoMakby	Modular biofabrication platform for building hierarchical tissue architectures

Makby IsoMakby

Two-Head Thermoregulated Extrusion Bioprinter

An affordable starting point for bioprinting, designed for researchers

A versatile extrusion bioprinting platform that combines precision mechanical extrusion, independent thermal control, multi-material printing, and complete freedom of substrates and software—giving researchers the flexibility to work with a wide range of bioinks while keeping operation simple, hygienic, and cost-effective.

The platform offers maximum flexibility, precision, and freedom throughout the bioprinting workflow. Researchers can print on Petri dishes, multiwell plates, Ibidi® chambers, and other custom supports, while using sterile 3 and 5 mL syringes without proprietary consumables.

Its mechanical extrusion system and independent thermal control support a wide range of bioinks and hydrogels, from gelatin and GelMA to collagen, alginate, fibrin, agarose, Pluronic, composite, and cell-laden formulations.

Dual integrated chillers, expandable to a third, enable precise temperature management for demanding and thermoreversible materials.

Designed for sterile and reliable operation, the system features hygienic surfaces, disposable components, compatibility with vertical laminar airflow, anti-drip retraction, and real-time Z-axis adjustment for improved print quality.

Although IsoMakby has integrated Makby Studio, the entire control interface is browser-based and software-agnostic, with no proprietary installation or closed ecosystem. Researchers can use free and open-source slicing software while retaining complete control over their designs, workflows, and manufacturing processes.

Extruders
Two independent print heads for multi-material printing.

Temperature regulators
Individual thermal control for each extruder; ideal for thermoreversible bioinks.

Cooling system
2 chillers included (one for the base and one for an extruder). The second extruder is prepared for the addition of a third optional chiller.



Syringes range
Compatible with 3 and 5 mL syringes in both printheads. Sterile, disposable, commercially available, and low-cost.

AISI 316 stainless-steel printing platform with mounting fixtures; working area of 120×120× 120 mm. Axis accuracy ~50 µm.

Printing Nozzles
Supports a wide range of interchangeable printing nozzles, with diameters ranging from 100 µm to 1,000 µm.

Supports
Freely selectable by the researcher: Petri dishes, multiwell plates, Ibidi® and others.

Mechanical extrusion (stepper motor + syringe-piston)
Precise control of flow rate and volume, suitable for a wide range of viscosities.

Anti-drip retraction system and real-time Z-height adjustment during G-code execution.

Makby PicoMakby

High-resolution Masked Stereolithography Bioprinter

High-resolution photobioprinting platform for bioink development and small-volume tissue-engineering research

The PicoMakby is an ideal platform for universities and research laboratories working in advanced materials, microfabrication, and bioprinting.

It enables precise testing of small volumes of high-value resins before scaling up to full-size production. With a minimum-volume configuration of just 1 mL, laboratories can screen and optimize formulations while using significantly less material—helping reduce both development costs and material waste.

With precise control over microarchitecture, the PicoMakby supports the development of advanced microfluidic constructs and other microscale structures.

When reproducing microarchitectures with features ranging from tens to hundreds of micrometers, accurate control of both XY and Z resolution is essential for achieving the desired geometry, dimensional accuracy, and structural fidelity.

Monochrome LCD technology enables shorter exposure times, offering benefits beyond increased printing speed.
In bioprinting and other sensitive applications, reduced exposure times can help minimize the duration that cells and biomolecules are subjected to UV or violet light, photoinitiator-generated radicals, prolonged irradiation, and potentially elevated local temperatures, depending on the printing system and material formulation.



Robust Engineering
Monochromatic 4K LCD with high speed curing time

High resolution and printing volume
The current resolution is 35µm on XY, so 700×700 pixels on a 24x24 mm area

Minimum and maximum layer thickness
33 µm/50 µm/100 µm per layer (Z resolution)

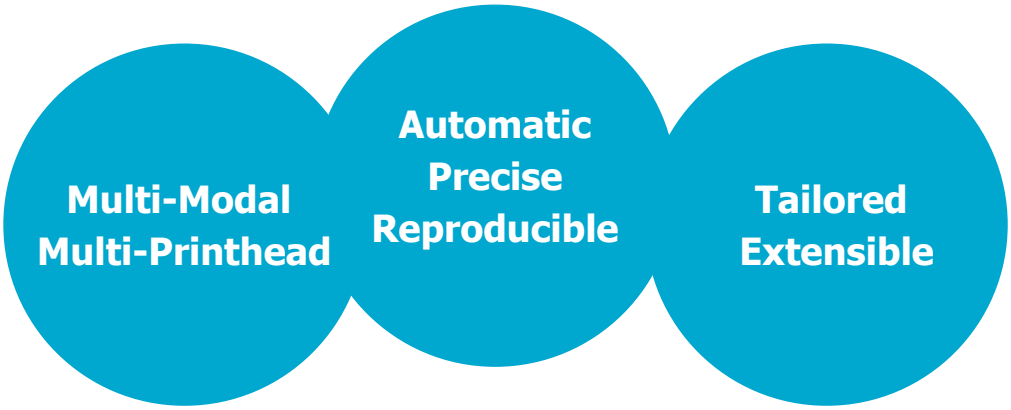
Intensity Range for each irradiation layer
3 mW/cm2 up to 30 mW/cm2

Customizable Vat
From 50x50 mm, 25x25 mm down to 15x15 mm

Supports multiple files
STL files as well as image files

Makby DomoMakby

Modular biofabrication platform for building hierarchical tissue architectures

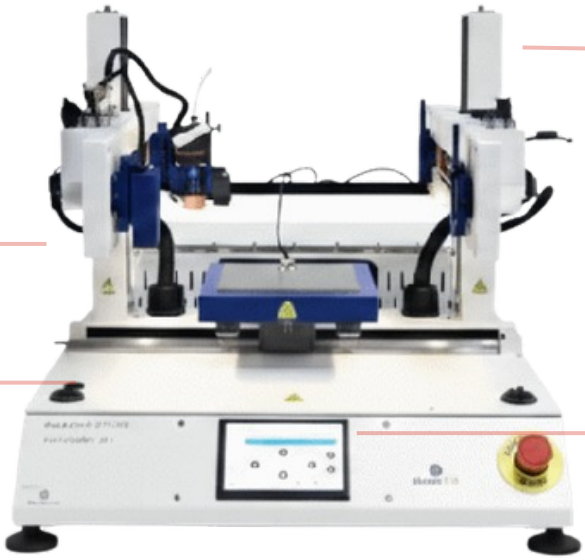


High-precision bioprinting

Exceptional accuracy and consistent control across the X, Y and Z axes.

Robust Engineering

Designed for extended, repeated operation during intensive testing, the machine delivers reliable performance.



Multi-Printhead Compatibility

It can be configured with up to four different printheads at the same time, enabling operation with multiple fabrication techniques, including UV printing, electrospinning, melt electrowriting (MEW), and FDM.

Integrated Touchscreen

Configure complete bioprinting protocols directly from the system. The intuitive interface simplifies the upload and management of STL and G-code files for seamless operation.

The system supports up to four printheads, each of which can be loaded with different cell types, bioinks, or polymers. By combining multiple infill patterns across different layers and geometries, the platform enables virtually limitless possibilities for creating customized bioprinted constructs.

Makby DomoMakby

Chambers

Multiple chambers for maximum flexibility and controlled experimentation



Sterility-Ready Design

The DomoMakby printer can be easily placed inside any sterile chamber, allowing experiments to be performed under optimal sterile conditions.

Temperature-Controlled Chamber

The DomoMakby printer can be placed inside its dedicated temperature-controlled chamber. The chamber supports a temperature range from room temperature up to 55°C and a humidity of 30–75%.

For experiments requiring strict environmental control, a humidity controller can be added—essential for handling biomaterials or other materials sensitive to moisture.



The temperature chamber is not sterile and cannot be used inside a sterile hood. Temperature and humidity may be influenced by external environmental conditions.

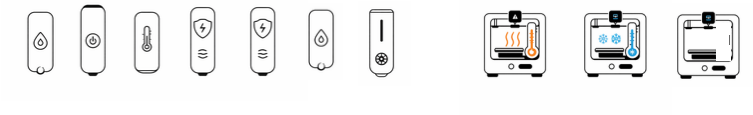
Makby DomoMakby

Printheads and Platforms

Easily swap printheads and build platforms to work with multiple materials, bioinks, or cell types

Work with up to four interchangeable printheads and temperature-controlled platforms simultaneously.

Choose up to **seven** interchangeable printheads and **three** platforms to tackle complex applications and create sophisticated biological architectures.





Automatic calibration assists the user in accurately calibrating the printing heads, ensuring optimal alignment and printing performance.

Pneumatic Printhead
Easy-to-use pneumatic printhead, available in a 3, 5 and 10 mL size for precise and reliable material extrusion. Max Viscosity 200 Pa·s.

Temperature-Controlled Printhead
Designed for the extrusion of temperature-sensitive materials (3, 5, and 10 mL), this printhead operates within a controlled temperature range from room temperature up to 55 °C. Max Viscosity 200 Pa·s.

Pellet Printhead (FGF)
Print synthetic polymers such as PCL, PLA, and PLGA to achieve enhanced biomimicry and complex structures.

Photo-Curing Printhead
Wavelength options: 365 nm, 405 nm. Enables targeted photocrosslinking of biomaterials with adjustable intensity, duration, and height.

Filament Printhead (FDM)
Designed for thermoplastic and composite filaments, filament-based materials offer consistent quality and easy handling, making them ideal for applications requiring high dimensional accuracy and stable mechanical properties.

Melt Electrowriting Printhead
The Melt Electrowriting module enables controlled deposition of molten thermoplastic polymers for the fabrication of high-resolution micro- and macro-scale structures. It allows precise fiber placement, adjustable filament diameters, and accurate layer-by-layer construction. Resolution from 2 up to 50 µm. Max Viscosity 200 Pa·s.

Electrospinning Printhead
The Solution Electrospinning module enables the generation of nano- to microscale fibrous structures through controlled deposition of polymer solutions under a high-voltage electric field. It allows fabrication of highly porous, biomimetic scaffolds with tunable fiber diameter and morphology that typically range from 50 nm to 20 µm. Compatible with a wide range of polymer solutions, it operates at room temperature only.

Cooling/Heating platform
This high-performance platform (120 x 120 mm) provides precise temperature control from 5 °C to 55 °C, supporting both cooling and heating functions. It ensures stable printing conditions for temperature-sensitive materials.

High-Performance Heating platform
This high-performance platform (120x120 mm) provides precise temperature control from room temperature up to 120 °C and serves as the base for construct printing. It supports materials that require specific temperatures to maintain liquid, viscous, or solid states during printing.

Drum collector platform
This platform (140 × 60 mm, 400–4000 rpm) is designed to collect and manage bioink or cellular material after printing or extrusion. Its purpose is often linked to maintaining the precision, sterility, and organization of the printed material.

Makby

SOFTWARE

PRODUCTS	CHARACTERISTICS
Makby Studio	Universal CAD/CAM Non-Planar Multi Material Software

Makby Studio

Universal CAD/CAM Non-Planar Multi Material Software

Adaptable software for complex multi-material scaffold design and intricate pathways

There is a growing demand for larger, more sophisticated 3D constructs that closely replicate native tissue features.

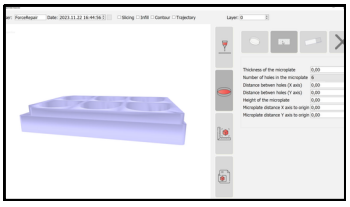


Optimise path planning and printing trajectory generation to minimise trajectory overlap through AI computational geometry optimisation.

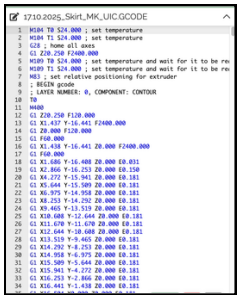
- An easy-to-use interface, combining CAD & CAM at the same time (**no programming knowledge required**).
- Compatibility with multi-material printing
- The ability to print both complex and simple scaffolds.
- Compatibility with any extrusion bioprinter.
- Webcam for Remote Monitoring is included to optimise the AI experience.

Users can **effortlessly design custom scaffolds**—whether simple cylinders or complex lattice structures—fine-tune internal architectures, and instantly generate print-ready G-code, all within a single, intuitive interface.

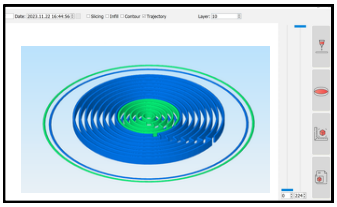
Shape Generator
Enables users to create simple 3D models without cumbersome CAD software. Select from ready to use geometries as boxes, cylinders, fractal, honeycomb or hemispheres, and if you need a specific shape, we can tailor it to your needs.



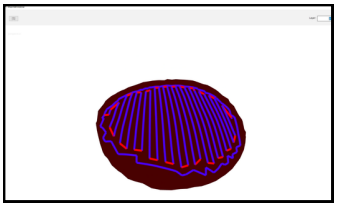
Decoding G-code
Develop G-Code directly from an STL file or edit it effortlessly using the integrated G-Code editor. Visualize the tool path and review every movement in detail.



Multi-material combination
Design architectures with multiple subvolumes and diverse microstructure patterns composed of various materials in a straightforward manner. Define intricate printing pathways by combining different printheads within the same layer, enabling the development of multi-material constructs with ease.



Nonplanar material distribution
Generate 3D bioprinting trajectories with non-planar layers to enhance scaffold surface finish. Design and evaluate optimal microstructural patterns by simulating multiple prototypes, ensuring the best balance of stiffness and porosity.



Makby

BIOMATERIALS

PRODUCTS	CHARACTERISTCS
PoloxInk	Custom Polyurethane Based on Poloxamer®407
GelMA Ultra	Custom Gelatin Methacryloylation
SUMC Ink Collacer®	Sterile Uniform Multitissue Compatible Collagen
SVPC Ink	Sustainable Visible-Light Photocurable Chitosan
SFCVC ink	Sacrificial Fungal-Derived Chitosan Visible Light Crosslinked
TRE Hydrogel	Tissue-specific Ready to Use Extracellular Matrix
4D-HTOR Hydrogel	4D-Printed Hybrid Thermo Optically Responsive

Makby PoloxInk

Custom Polyurethane Based on Poloxamer®407

Thermoresponsive by nature
Engineered for stability, performance, and control.

Poloxamer® 407 (P407) forms thermoresponsive hydrogels at body temperature without chemical crosslinkers, solvents, or UV irradiation. However, native P407 hydrogels are limited by high polymer loading, weak mechanical stability, rapid dissolution, and poor payload retention.

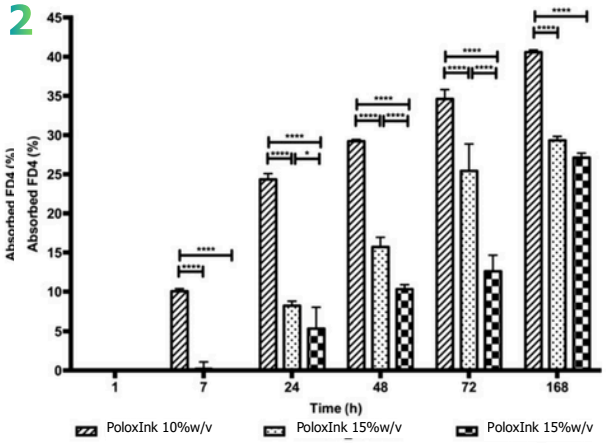
PoloxInk is an engineered poly(ether urethane) derived from P407 and designed to overcome these intrinsic limitations while retaining its valuable thermoresponsive properties.

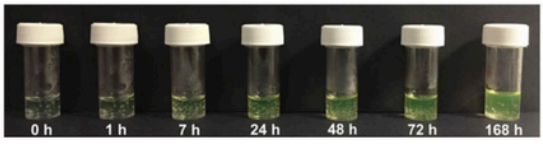
- Thermo-responsive ink characterized by sol-to-gel transition upon temperature increase and fast gelation kinetics
- High stability in contact with fluids.
- Extrudability through nozzles of different diameters under mild processing parameters.
- Versatile drug delivery systems able to (co-currently) encapsulate drugs of different origin (e.g., hydrophobic and hydrophilic molecules, proteins, labile molecules, therapeutic ions).
- Possibility to finely tune the gelation temperature and kinetics by changing the polymeric concentration.
- Remarkably higher stability in contact with fluids compared to corresponding formulations based on the commercially available Poloxamer® 407.

1



2





doi 10.1002/pi.5080

Results

- Formulations at 15% w/V extruded at 25 °C through G27 nozzles require extrusion pressures in the range 70 – 100 kPa
- Rapid temperature-triggered gelation (<5 min at 37 °C) without chemical crosslinkers, solvents, catalysts, or UV curing [1]
- Continuous FD4 diffusion demonstrates effective molecular transport through the bioink matrix [2]

AVAILABLE FORMATS

- Powder form for custom formulations and extended shelf life (1g, 5g)
- Custom formats available upon request

Makby GelMA Ultra

Ultra-High Crosslinking
Ultra-Low Polymer Load
Maximum Biological Potential

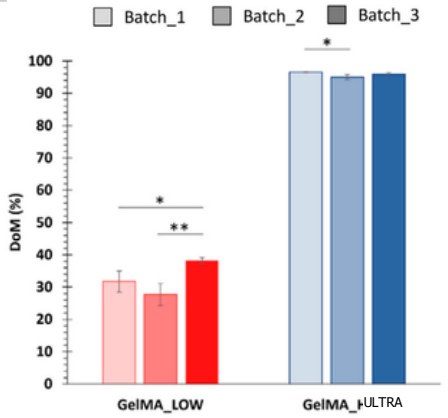
Custom Gelatin Methacryloylation

Conventional GelMA bioinks often require high polymer concentrations for stability at 37°C, resulting in dense networks, increased swelling, and limited molecular transport.

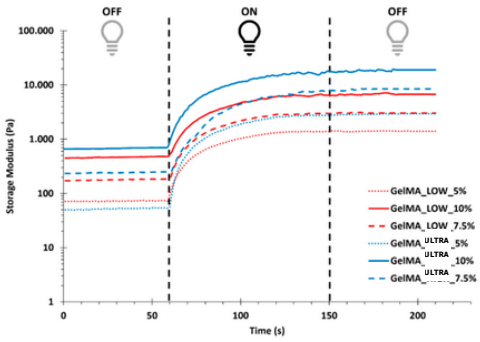
GelMA Ultra overcomes these limitations with 96–97% methacryloylation degree (DOM), delivering hydrogeles with tissue-relevant stiffness, structural stability, efficient mass transport, and rapid photocrosslinking.

- Thermo- and photo-sensitive bioinks characterized by easily tunable printing parameters based on external stimuli (i.e., temperature and light irradiation)
- Extrudability under mild processing conditions
- Tunable mechanical properties based on the selected composition
- Responsiveness to both UV (e.g., 365 nm) and Visible light (e.g., 405 nm and 525 nm) by using low concentrations of type I or type II photo-initiators
- High cytocompatibility and cell supporting proliferation
- High stability of GelMA Ultra-based gels in contact with fluids
- Possibility to finely tune the degree of methacryloylation (lower DoM can be available on demand)
- Possibility to synthesize GelMA starting from gelatin of different origin (e.g.,porcine, bovine, fish)

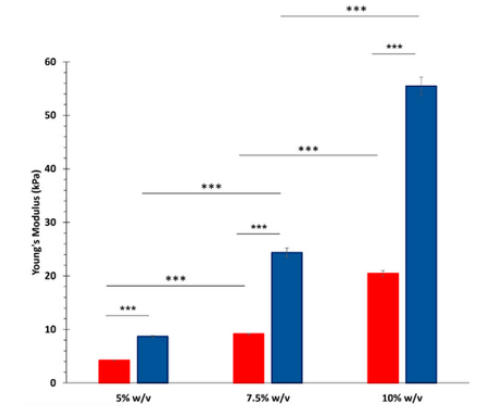
1



2



3



doi.org/10.3389/fbioe.2025.1576824

Results

- High reproducibility with consistent Degree of Methacryloylation (DoM) of 30–40% for GelMA Ultra_LOW and 96–97% for GelMA Ultra [1]
- Rapid Photopolymerization reaches a stable plateau in ~40 seconds [2]
- Tissue-relevant stiffness, with 5% w/v GelMA Ultra achieves 8.70 ± 0.12 kPa, within the myocardial tissue range (8–15 kPa) [3]

AVAILABLE FORMATS

- Powder form for custom formulations and extended shelf life (1g, 5g)
- Custom formats available upon request

Makby SUMC Ink
Collacer®

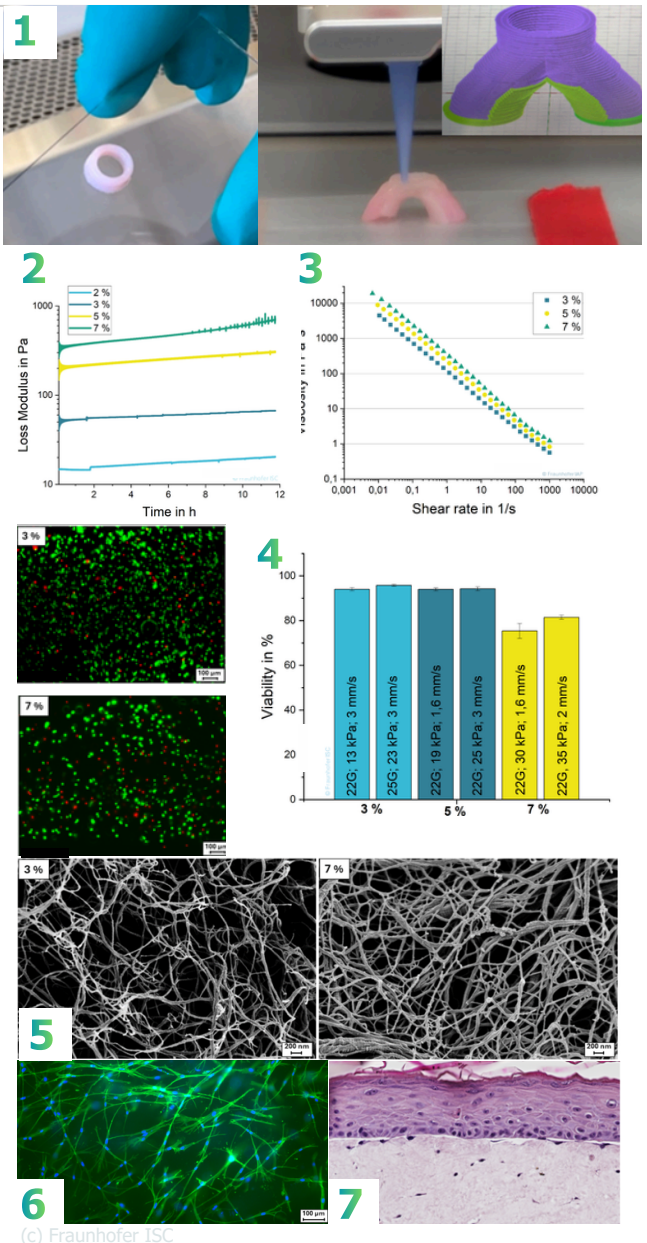
Sterile Uniform Multitissue Compatible Collagen

Collagen type 1 to strengthen the performance of your bioinks

To reach impact, bioprinted constructs must combine mechanical strength with biological relevance.

SUMC Ink Collacer® consists of **collagen** that reinforce printed structures, improving shape fidelity and biological performance. With excellent chemical stability, they **integrate** seamlessly with a wide range of **bioinks** and bioprinting platforms.

- Demonstrated ink stability under storage and handling conditions at 15 °C. Can be stored at temperatures below 5 °C and is freezable, providing flexibility for storage and transportation.
- Designed to undergo gelation at physiological temperature, supporting bioprinting and tissue-engineering applications.
- Formation of a physiological fibrillar structure.
- Compared with pure collagen, the formulated bioink gels demonstrated I) increased fibril homogeneity, II) a higher proportion of striated fibrils, III) increased fibril-network density at higher concentrations.
- Tested with human fibroblasts, demonstrating cell viability of 70–90% under the tested printing conditions.
- Already optimized to specificic Printing Parameters
- Bioink formulations have been tested for applications involving: Skin, Cardiac and Intestinal tissue.



(c) Fraunhofer ISC

Results

- Concentrations ≥5% enable stable freestanding structures; overhangs require support [1]
- Good stability at 15 °C over 12 h; 10 °C recommended for optimal printing [2]
- Bioinks show shear-thinning behavior, supporting extrusion and shape retention [3]
- Conditions support high fibroblast viability. Recommended conical nozzles: 3%: 22G–25G | 5%: 22G | 7%: 20G–22G [4]
- Higher concentrations increase fibril density, enabling tunable gel microstructure [5]
- Fibroblasts show successful attachment and spreading within the gel [6]
- Successful fabrication of a full-thickness skin equivalent demonstrates the bioink's tissue-engineering potential [7]

AVAILABLE FORMATS

- Sterile, ready-to-use cartridges compatible with major bioprinters, available in 3 mL and 5 mL formats
- Powder form for custom formulations and extended shelf life
- Custom formats available upon request

Makby SVPC Ink

Sustainable Visible-Light Photocurable Chitosan

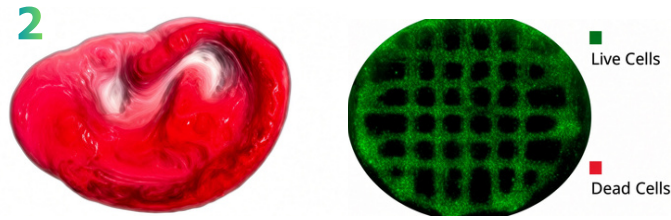
The bioink that becomes the construct

Increasing polymer concentration or crosslinking improves structural stability but can impair extrusion, diffusion, and cellular compatibility, highlighting the rheology–structure–biology trade-off in bioink design.

SVPC Ink is a **ready-to-use**, **animal-free structural bioink** based on **fungal-derived chitosan**, designed to form the printed construct itself. It combines shear-thinning rheology with rapid visible-light curing for controlled extrusion and high shape fidelity. Compatible with **extrusion**, **DLP**, and **VAM** bioprinting, it enables versatile cell-laden fabrication. UV-free, cytotoxic-photoinitiator-free curing enhances cell compatibility, while water solubility simplifies processing. SVPC Ink remains stable in culture media for **over 30 days**, supporting extended tissue development without post-print reinforcement.

- Fungal-derived chitosan — animal-free, sustainable, and designed for high biocompatibility.
- Visible-light curing, crosslinkable under visible light with no UV exposure required.
- No cytotoxic photoinitiators where the formulation is designed to to support cell-compatible printing.
- Multi-platform compatible, suitable for extrusion, DLP, and VAM bioprinting technologies.
- High shape fidelity, maintains printed geometry and structural integrity after deposition/curing.
- Cell-laden printing, enables fabrication of load-bearing constructs containing living cells, supporting water solubility and handling at physiological pH. High cell viability, demonstrated >80% cell viability with long-term culture stability, remains stable in cell culture media for 30+ days.





KEY PROPERTIES

Source	Fungal chitin (animal-free)
Crosslinking	Visible light (no UV, no cytotoxic initiators)
Rheology	Shear-thinning, tun able viscosity
Shape Fidelity	High
Bioactivity	Bioactive, Antioxidant, and antibacterial
Cell Viability	>80% in vitro
Degradation	Controlled enzymatic degradation, tunable
Stability	>30 days in culture media
Printing	Extrusion, DLP, VAM

COMPARATIVE ADVANTAGES

Criteria	SVPC Ink	GelMA	Alginate	Collagen	Chitosan (Others)	Synthetic PEG
Animal-free	Yes	No	Yes	No	Yes	Yes
Visible-light crosslink	Yes	Yes (blue)	No	No	No	No (UV)
Tunable viscosity	Yes	No	Limited	Low	Limited	Yes
Bioactive	Yes	Low	Low	Moderate	Yes	No
Compatibility >80%	Yes	Yes	Yes	Yes	Yes	Low
Controlled degradation	Yes	Poor	Poor	Poor	Yes	No
Cell attachment	Low	Yes	No	Yes (green)	Low	No

Results

- Designed for use across extrusion, DLP, and volumetric additive manufacturing (VAM) platforms,
- The printed ear construct maintained its shape after 30 days in cell culture medium
- Live/dead staining after 7 days demonstrated high cell compatibility

AVAILABLE FORMATS

- Sterile, ready-to-use cartridges compatible with major bioprinters, available in 3 mL and 5 mL formats
- Powder form for custom formulations and extended shelf life
- Custom formats available upon request

Makby SFCVC ink

Sacrificial Fungal-Derived Chitosan Visible Light Crosslinked

Complex architectures shouldn't be limited by how you remove them

When fabricating perfusable channels, vascular networks, and intricate 3D architectures, temporary support materials are often essential, but removing them can become the bottleneck.

SFCVC Ink is a **visible-light**-responsive sacrificial biomaterial built on **fungal-derived** chitosan, designed to create temporary support structures for complex biofabrication.

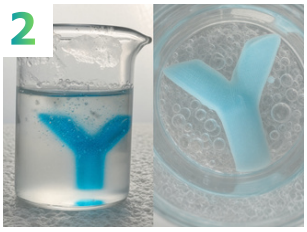
Its crosslinks cleave under visible light with no UV or temperature shifts required, enabling residue-free removal either through light-triggered dissolution or simple soaking and washing.

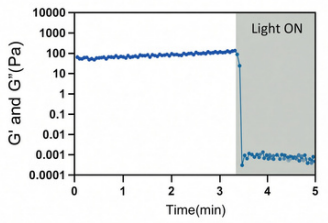
- Suitable to print perfusable channels for advanced tissue models.
- No temperature shift required, working at physiological conditions.
- Non-toxic removal process preserves cell viability.
- Water-soluble and easy to handle under physiological pH conditions.
- Residue-free - leaves clean channels and structures
- Temporary structures, acting as a support to build constructs with precise architecture.

1



2





KEY PROPERTIES

Source	Fungal chitin (animal-free)
Crosslinking	Dynamic covalent bonds
Aging	Programmable lifetime (seconds to days)
Removal	Light-triggered dissolution or soaking
Biocompatibility	Cell-friendly, non-toxic
Residue	Residue-free removal
Printing	Extrusion
Self-healing	Yes

COMPARATIVE ADVANTAGES

Criteria	SFCVC Ink	Other Sacrificial Inks
Visible light dissolution	Yes	No
No temperature shift	Yes	No (therma)
Non-toxic removal	Yes	Varies
Cell friendly	Yes	Limited
Good printability & resolution	Yes	No
Self-healing	Yes	Yes
Reversibility	No	Variable

Results

- Embedded printing capability to print directly within the SFCVC Ink support bath, enabling the fabrication of complex structures [1]
- Once exposed to visible light, the support bath dissolves within minutes, enabling straightforward recovery of the printed construct [2]
- Transition from a stable support bath to rapid dissolution is activated by visible light [2]

AVAILABLE FORMATS

- Sterile, ready-to-use cartridges compatible with major bioprinters, available in 3 mL and 5 mL formats
- Powder form for custom formulations and extended shelf life
- Custom formats available upon request

Makby TRE Hydrogel

Tissue-specific Ready to Use Extracellular Matrix

Reproduce and better mimic the native Extracellular Matrix

Recreating the complexity of the native extracellular matrix (ECM) remains a key challenge in tissue engineering.

Our **ready-to-use, tissue-specific ECM** formulations closely mimic native cellular microenvironments, providing biochemical, structural, and tissue-specific cues while supporting thermal and photo-responsive crosslinking.

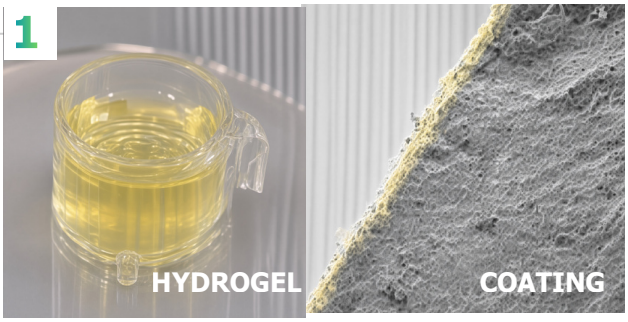
Optimized for bioink and bioresin applications, they are **compatible** with **extrusion- and light-based** bioprinting. Formulations can be directly gelled for **3D** applications or diluted for **2D** cell culture and surface **coating**, offering a versatile, tissue-specific ECM solution for advanced tissue engineering and regenerative medicine.

- Tissue-specific biomaterials designed to closely reproduce the biochemical and structural cues of the native extracellular matrix (ECM).
- Tissue-specific ECM solutions available for Liver, Skin, Pancreas and Intestine.
- Custom ECM formulations can be developed to meet the specific requirements of different tissues, cell types, and applications.
- Light-triggered crosslinking, activated by 320–500 nm light
- Compatible with for extrusion and light-based bioprinting.

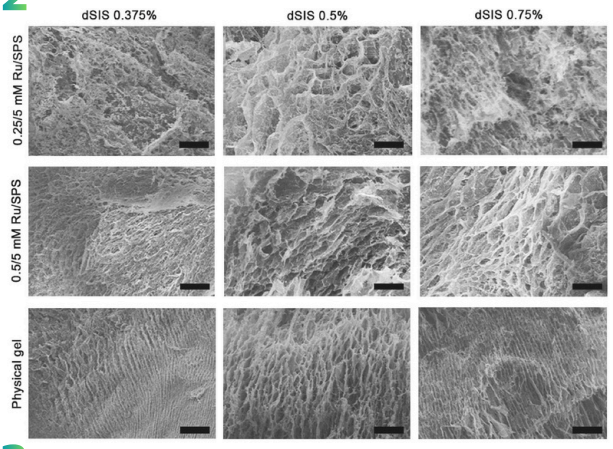
AVAILABLE FORMATS

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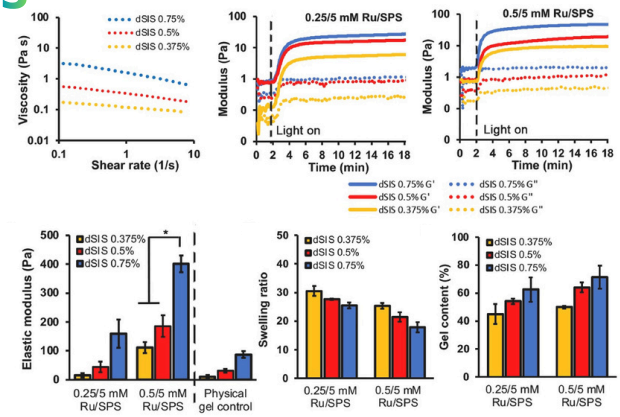
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Results

- Versatile formats: Hydrogels and coatings [1]
- Tissue-mimetic ECM: Native tissue-specific structure (e.g., dSIS hydrogel) [2]
- Shear-thinning for smooth, consistent extrusion
- Rapid photocrosslinking for Fifast, controllable in situ gelation [3]
- Tunable mechanics for adjustable elastic modulus through resin concentration and formulation [3]

Makby 4D-HTOR Hydrogel

From static scaffolds to living lung models 4D printing that moves, responds, and mimics breathing

4D-Printed Hybrid Thermo Optically Responsive

Conventional bioinks and hydrogels are largely passive, limiting their ability to replicate the dynamic mechanical microenvironment of living tissues with precise spatial and temporal control. They also face challenges in balancing softness, biocompatibility, printability, and architectural fidelity.

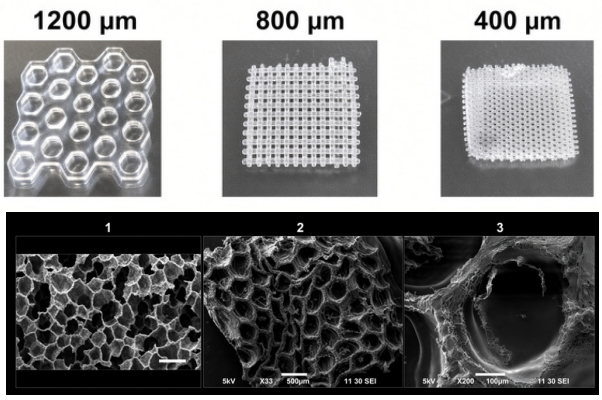
The **4D-HTOR** hydrogel addresses these limitations by **integrating** N-vinyl caprolactam (**VCL**), polyethylene glycol diacrylate (**PEGDA**), and functionalized plasmonic gold nanorods (**AuNRs**). **Combining high-resolution vat** polymerization with **thermoresponsive** and plasmonic properties, **800 nm NIR** irradiation induces AuNR-mediated photothermal stimulation, triggering reversible **VCL swelling–shrinkage** and approximately 6% cyclic contraction–expansion, while **400 µm honeycomb cavities** reproduce alveolar architecture.

- LCD-printable resin enabling intricate, micron-scale tissue architectures.
- Dynamic, reversible actuation rather than a static scaffold, providing physiologically relevant mechanical stimulation.
- 800 nm NIR light enables remote, cyclic swelling/shrinking with ~6% reversible deformation.
- 400 µm honeycomb cavities mimic key features of alveolar geometry.
- Polyarginine-functionalized gold nanorods enhance lung epithelial cell attachment.
- Supports epithelial monolayer formation and activates mechanotransduction pathways under dynamic stimulation.
- Integrates printability, thermoresponsiveness, optical actuation, biomimetic architecture, and cell-interactivity in one resin.
- Promising lung-on-chip platform for studying cell behavior and mechanical responses in more physiologically relevant models.

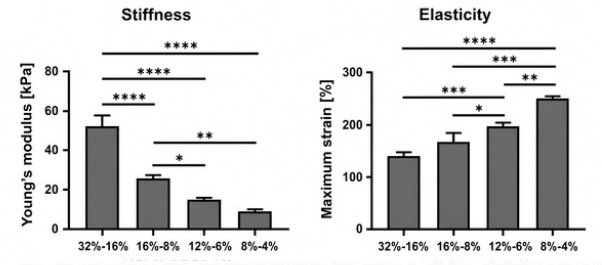
AVAILABLE FORMATS

- Sterile, ready-to-use cartridges compatible with major bioprinters, available in 3 mL and 5 mL formats
- Powder form for custom formulations and extended shelf life
- Custom formats available upon request

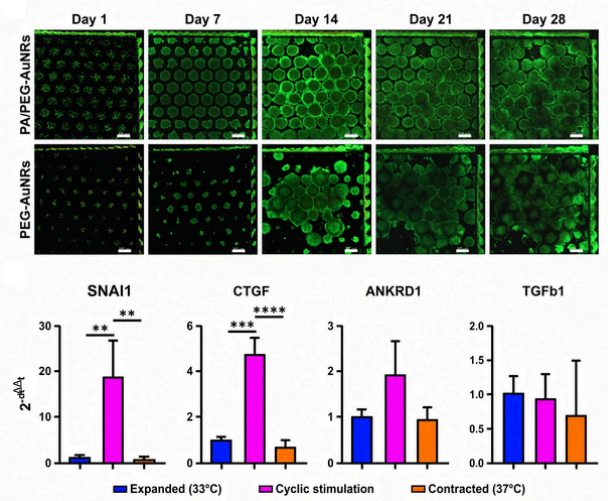
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Results

- Customizable geometry pattern (honeycomb) scaffolds with gradually decreasing pore sizes, mimicking human lung architecture [1]
- Thermoresponsive materials with tunable mechanical properties [2]
- Scaffold functionalization with PEG-AuNRs or PA/PEG-AuNRs at different time points to study genetic responses to mechanical and thermal stimuli [3]

Makby

PLATFORMS

PRODUCTS	CHARACTERISTCS
OmniEnzyme	High-Throughput Screening of Bioinks, Encapsulated Drugs, and Enzymes
CapilPro	Precision Engineering Glass Capillaries

Makby OmniEnzyme

High-Throughput Screening of Bioinks, Encapsulated Drugs, and Enzymes

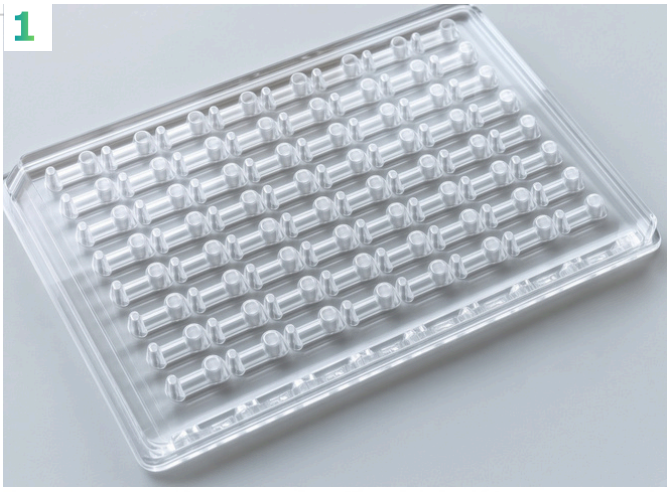
Scale enzyme and bioinks formulation screening without scaling complexity

Developing bioinks, biocatalysts and encapsulated drugs requires testing numerous variants and formulations. Conventional screening is time-consuming, costly, and material-intensive, creating a need for efficient parallel testing.

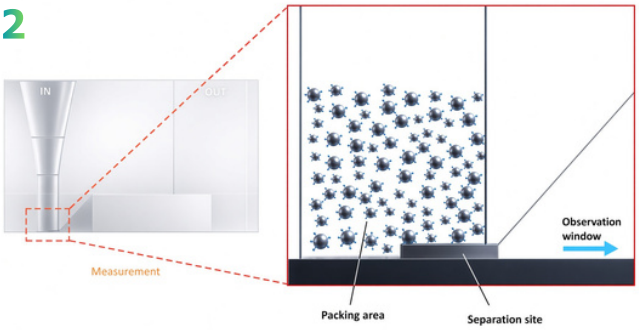
Makby **OmniEnzyme** addresses the challenge of screening multiple enzyme variants and reaction conditions efficiently. Its **384-well compatbile** format enables parallel testing using small amounts of material, **reducing reagent use**, cost, and screening time. An inlet channel **guides microparticles and active reagents** directly into the reaction area for controlled delivery. The platform can also support bioink development by enabling simultaneous testing of different formulations, including polymers, cells, crosslinkers, additives, and processing conditions.

- A unique physical obstruction forms a separation site that isolates the primary reaction area from a downstream detection area.
- The detection area includes an observation window optimized for monitoring analytical readouts, paired with an outlet channel that releases displaced air to ensure smooth fluid flow.
- 64 parallel readings, compatible with 384-well format, this platform does not require pumps or valves, and it can compare enzymatic activity with various substrates or inhibitors, temperature, and pH, without losing enzymes.
- By arranging a plurality of these bioreactors into a single automated platform, the system allows researchers to perform rapid, parallelized screening of enzyme candidates and bioinks conditions with minimal volume requirements.
- Suitable for screening bioinks, enzymes, antibodies, encapsulated drugs and antibodies.

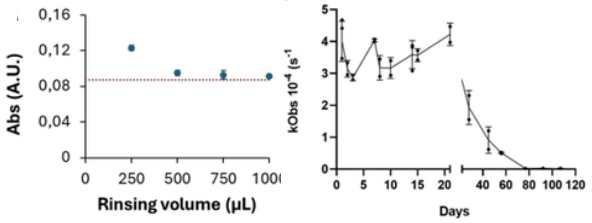
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Results

- 64 parallel measurements, compatible with a 384-well plate format [1]
- Microscale packed-bed reactors, in which microparticles (µPs) functionalized with metal-affinity groups retain polyhistidine (His)-tagged enzymes, enabling enzyme reuse [2]
- Reusability of the microfluidic screening platform, demonstrated over increasing reaction volumes and sustained for several months, as shown for AldOTf (alditol oxidase from Thermopolyspora flexuosa) [3]

Makby CapilPro

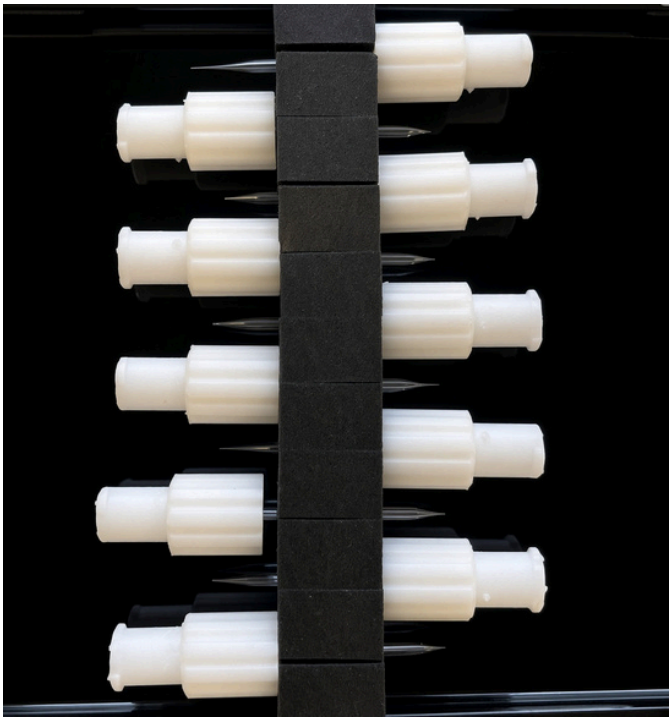
Precision Engineering Glass Capillaries

Customizable Sterilizable Glass Capillaries

Precision-engineered glass capillaries with customizable diameters up to 2 mm, manufactured to meet specific experimental requirements and characterized by Scanning Electron Microscopy (SEM).



- Custom Dimensions: Tailored inner and outer diameters to suit your application, from fine microcapillary tips to larger diameters up to 2 mm.
- Precision Fabrication: Glass capillaries are precisely pulled to produce sharp, conical tips with controlled geometries.
- Fine Tip Customization: Tips can be trimmed and polished to achieve precise inner diameters, typically ranging from 20 to 80 µm.
- Sterilizable: Suitable for applications requiring sterilization and controlled handling.
- SEM Characterization: Tip geometry and dimensions can be verified using Scanning Electron Microscopy (SEM).
- Precision Dispensing: Compatible with custom piston-driven or piezoelectric actuation systems for controlled picoliter-scale dispensing.
- For pneumatic and mechanical extrusion bioprinting, this system is ideal for the controlled delivery of hydrogel-based drug formulations.



Makby

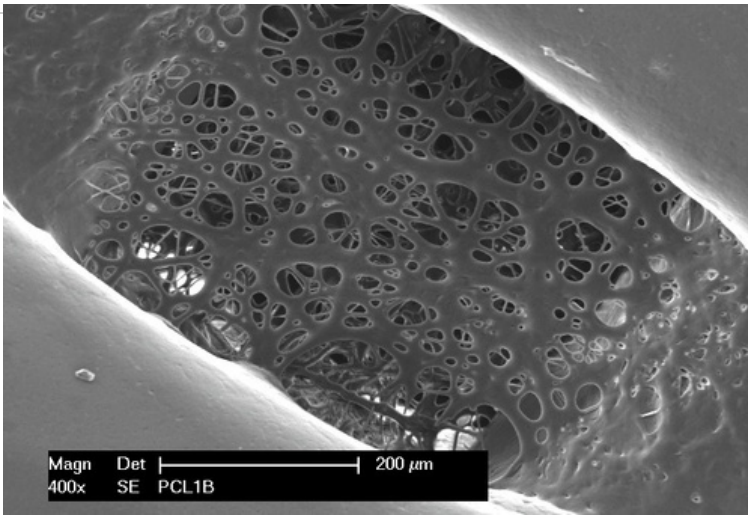
BIOMATERIALS & SCAFFOLDS

SERVICES	CHARACTERISTCS
Material Lab	Technical Validation for new 3D bioprintable materials
ScaffoldDynamics	Precise Scaffold Architecture Mapping
Lasing MicroCraft	Nanosecond Laser Microfabrication
Pre-Clinical Biomaterials	In vitro, In vivo Studies for Next-generation Biomaterials

Makby Material Lab

Biomaterial Performance Characterization

Technical Validation for new 3D bioprintable materials

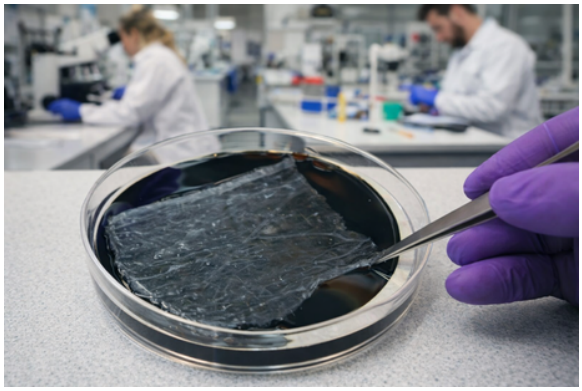


We provide specialized technical consulting to characterize, optimize, and validate **new materials** for bioprinting applications.

This service is designed for clients who need to assess the feasibility of their biomaterials on printing platforms — even without pre-existing protocols.

Our Services Include:

- Development and optimization of customized printing protocols
- Fabrication and testing of scaffolds under defined parameters (geometry, environment, and processing conditions)
- Evaluation of structural stability and post-printing performance
- Material engineering and formulation optimization (viscosity, crosslinking, mechanical strength, biocompatibility)
- Comprehensive technical reports with results, recommendations, and operational guidelines
- Advanced services as Spectroscopy (FTIR, Raman, UV-Vis, NMR); Microscopy (SEM, TEM, AFM, MEB); Thermal properties (TGA, DSC, DMA); Mechanical properties (Tensile, compression, fatigue, rheology); Surface analysis (XPS, contact angle)





Makby ScaffoldDynamics

Precise Scaffold Architecture Mapping

From structure to function

Next-generation 3D-printed scaffolds require deeper Insights into scaffold evolution and cell–matrix interactions.

At Makby, we provide an integrated **workflow for advanced scaffold visualization** and characterization.

Leveraging our proprietary laser-scanning nonlinear microscopy platform, we deliver **high-resolution, label-free structural mapping** combined with multi-channel fluorescence analysis to support cutting-edge 3D bioprinting research.

Our Advanced Characterization Services

Structural Mapping of Decellularized 3D Bioprinted Scaffolds

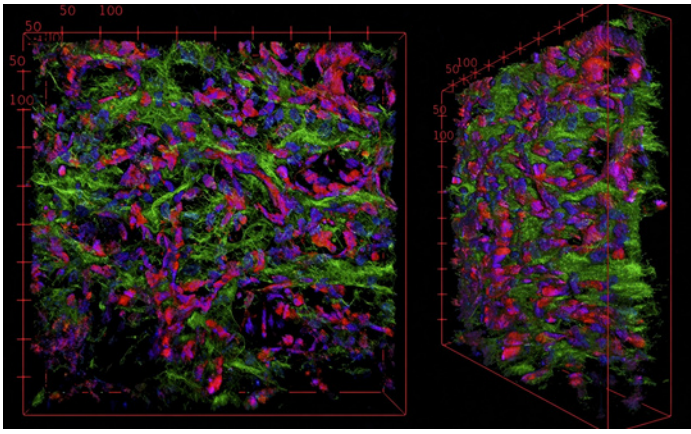
Comprehensive architectural analysis of scaffold morphology, fiber organization, porosity, and structural integrity to ensure design fidelity, performance, and reproducibility.

Dynamic Mapping of Cell-Laden 3D Bioprinted Scaffolds

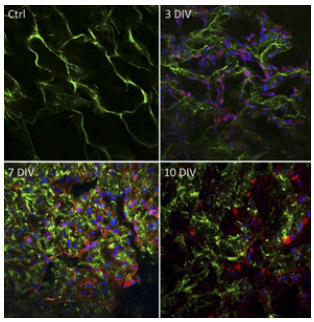
Advanced characterization of living constructs, including:

- Temporal scaffold evolution
- Collagen fiber orientation and remodeling
- Structural integrity under dynamic conditions
- Cell distribution, viability, and matrix interactions

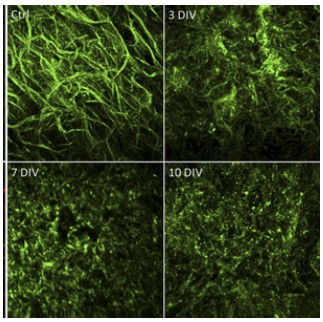
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Results

- **Cell and scaffold imaging**: HUVECs/MSCs are fluorescence-labeled, while collagen is visualized label-free by SHG [1]
- **3D cell infiltration**: Z-stacks reveal cell distribution and penetration depth within the collagen scaffold [1]
- **Cell–matrix dynamics**: Multimodal microscopy tracks cell colonization, interactions, and scaffold remodeling over time [2]
- **Structural remodeling**: Comparison at 3 and 10 days shows substantial changes in SHG struts. composite collagen images generated by integrating all polarization states and z-planes [3]

Makby Lasing MicroCraft

Nanosecond Laser Microfabrication

Engineering the Future of Microfluidics, Implants & Biomedical Devices

Next-generation biomedical technologies require increasingly precise control of materials, surfaces, fluids and cells at the micro- and nano-scale.

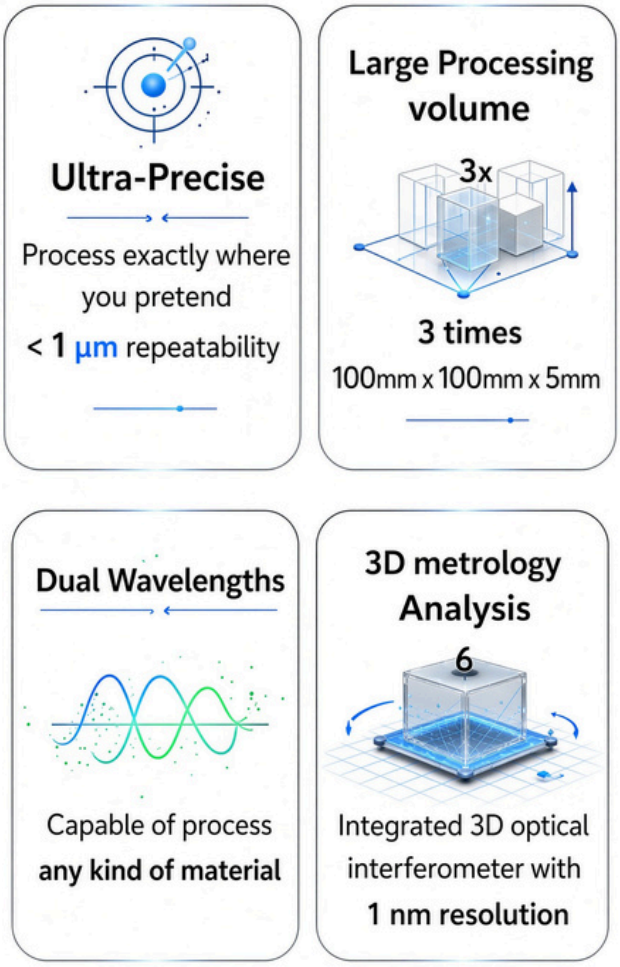
Advanced femtosecond and nanosecond laser microfabrication platforms enable on-demand, high-precision manufacturing of complex micro- and nano-scale structures.
With precision motion, advanced optics, glass processing, 3D structuring and integrated 3D metrology, Lasing enables customers to move rapidly from digital design to functional device.

Microfluidics: Create advanced glass microchannels, 3D fluidic networks, cell traps, mixers, gradients and organ-on-chip architectures without masks or dedicated tooling.

Orthopedic Technologies: Engineer titanium and other biomaterial surfaces with precisely controlled micro- and nano-topographies designed to improve the interaction between implants and biological tissue.

Advanced Biomaterials & Tissue Engineering: Create cell-guiding topographies, biomimetic surfaces, vascular-like microstructures and functionalized scaffolds at the scale where cells interact with materials.

Photonic & Biosensing Devices: Combine microfluidics with optical waveguides, micro-optics and integrated sensing structures to develop next-generation lab-on-chip and biosensing platforms.



Why use laser microfabrication

- Micro- and nano-scale fabrication
- Direct digital manufacturing without masks or molds
- Complex architectures beyond conventional planar fabrication
- Glass, metals, polymers and advanced biomaterials
- ontrolled micro- and nano-topographies
- From R&D and prototyping to industrial manufacturing

Makby Pre-Clinical Biomaterials

In vitro In vivo Studies for Next-generation Biomaterials

Accelerate the translation of next-generation biomaterials and implantable medical devices



Robust preclinical in vivo studies are essential for validating the safety, functionality, and translational potential of next-generation biomaterials and implantable medical devices.

These studies provide high-value datasets supporting the development of regenerative medicine technologies, implantable constructs, and advanced therapeutic platforms.

Applicable to technologies including:

- 3D bioprinted scaffolds
- Hydrogel patches
- Implantable regenerative constructs
- Bioengineered medical devices

Benefits of In Vivo Preclinical Studies for Next-Generation Biomaterials

Translational Validation
In vivo models bridge the gap between in vitro experimentation and human clinical application, providing predictive biological responses within complex living systems.

Safety and Biocompatibility Validation
Evaluation of biocompatibility, toxicity, and immunological response in physiologically relevant environments to ensure safe interaction between biomaterials and host tissues.

Functional Performance Assessment
- Tissue integration
- Neovascularization
- Mechanical stability
- Biomaterial degradation kinetics
- Long-term implant functionality

Biomaterial Design Optimization
Experimental feedback in real host tissue enables refinement of:
- Scaffold architecture
- Biomaterial composition
- Mechanical properties
- Controlled degradation profiles

Regulatory Readiness
Generate datasets through structured preclinical studies aligned with regulatory expectations from agencies such as U.S. Food and Drug Administration and European Medicines Agency.

Why Partner with Makby Preclinical

- **Trusted Expertise:** GLP-certified services (In vivo and in vitro toxicity, tolerance (dermal, ocular), pharmacodynamics, test product administration and specimen procurement, biocompatibility of healthcare products); ISO 9001:2015 quality and AAALAC-accredited animal care. Rigorous animal welfare oversight and expert surgical teams.

- **Cutting-Edge Tools & Techniques:** Minimally invasive surgery procedures (Laparoscopy, Endoscopy, Interventional radiology, Microsurgery) Robotic-assisted surgery (DA VINCI XI, SYMANI AND VERSIUS), advanced imaging (Half-arc fluoroscope, Ultrasound scanner, 3 Tesla Magnetic Resonance Imaging (MRI)), and 3D printing for prototyping and simulation.

- **Tailored Solutions:** Wide range of clinically relevant small and large animal models (Rodents, Lagomorphs, Swine, Sheep, Canine) designed for the specific technology needs.

- **AI-Driven Insights:** Predict biomaterial interactions, tissue integration, and physiological responses to optimize outcomes.

A fast-track technology translation platform that turns your concept into clinically validated solutions.



CONTACT OUR TEAM TO RECEIVE TAILORED SCIENTIFIC ADVISES ON YOUR TISSUE ENGINEERING PROJECT

Makby

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