# INTRODUCING FRAUNHOFER IGB

Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB

EuCheMS General Assembly, 10th of September 2016, Seville, Spain
Achim Weber



University of Stuttgart
Institute of
Interfacial Process Engineering
and Plasma Technology

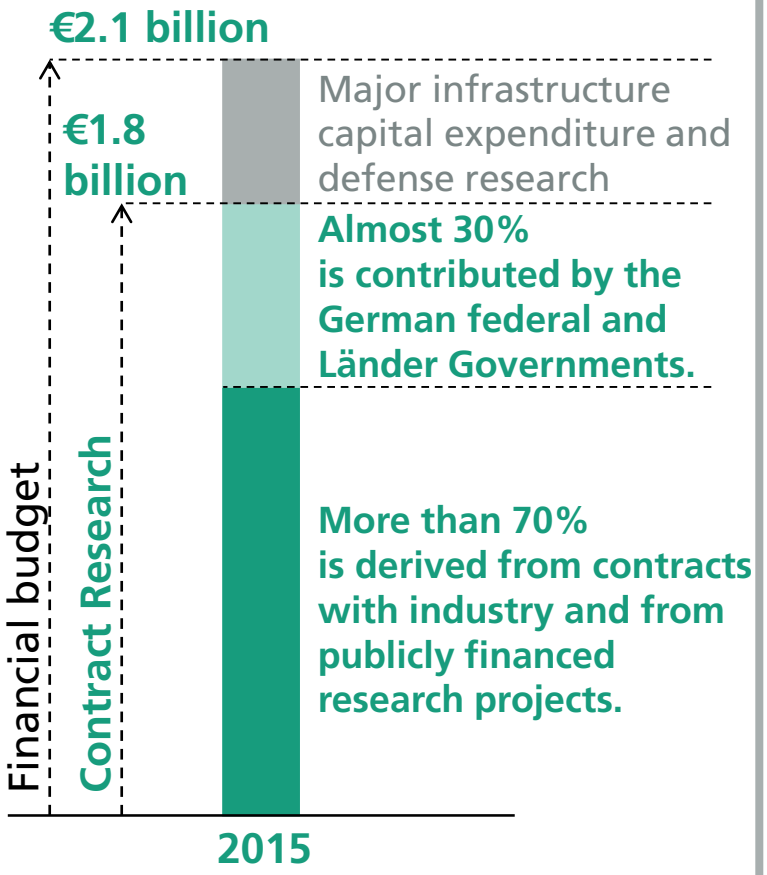
Fraunhofer
IGB

# The Fraunhofer-Gesellschaft at a Glance

**The Fraunhofer-Gesellschaft undertakes applied research of direct utility to private and public enterprise and of wide benefit to society.**

**24,000** staff


**67** institutes and research units



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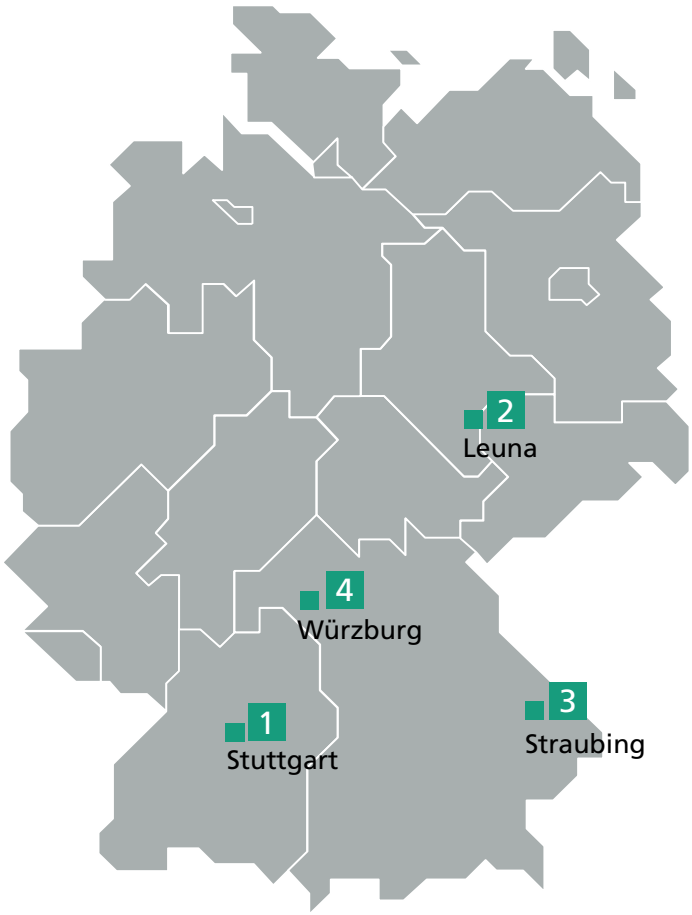
# Fraunhofer IGB facts and figures

- Founded in 1953, since 1962 within the Fraunhofer-Gesellschaft
- Located in Stuttgart since 1969, 1976 called Fraunhofer IGB
- 391 employees with €26 million operational budget (2015)
- Approx. 7200 $m^2$ total area

# Locations of Fraunhofer IGB





Fraunhofer Institute for Interfacial Engineering and Biotechnology **IGB**, location Stuttgart


Fraunhofer Center for Chemical-Biotechnological Processes **CBP**, Leuna branch


Bio, Electro and Chemocatalysis **BioCat**, Straubing branch


Translational Center “Regenerative Therapies for Oncology and Musculoskeletal Diseases“ **TZKME**, Würzburg branch



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# Research & Business areas

## Health

- Coatings and biomaterials for medical applications
- Molecular diagnostics
- Personalized medicine
- Drug discovery and development
- Formulation and release systems
- Food and cosmetics

## Chemistry and Process Industry

- Functional surfaces and materials
- Fermentation and biocatalysis
- Biobased chemicals
- Biorefinery concepts
- (Electro-)chemical conversion
- Downstream processing

## Environment and Energy

- Water and wastewater technologies
- Water monitoring
- (Re)processing of raw and residual materials
- Energy conversion and storage
- Bioenergy

# Organigram

**Directors (acting)**
Prof. Dr. Katja Schenke-Layland
(executive)
Hon.-Prof. Dr. Christian Oehr

**Deputy Director**
apl. Prof. Dr. Steffen Rupp

**Assistants to Director**
Christine Demmler
Sara Bevilacqua

**Business Development**
Dipl.-Agr.-Biol. Sabine Krieg MBA
Dr. Uwe Vohrer

**University of Stuttgart Liaisons**
apl. Prof. Dr. Günter Tovar

**Press and Public Relations**
Dr. Claudia Vorbeck

**Administration**
Human Resources and Organization
Katja Rösslein M. A.

Controlling and Finance
Dipl.-Kfm. Michael Bangert

**Fraunhofer CBP, Leuna branch**
Dipl.-Chem. (FH) Gerd Unkelbach

**BioCat, Straubing branch**
Prof. Dr. Volker Sieber

**Translational Center Regenerative Therapies, Würzburg branch**
Prof. Dr. Heike Walles

| **Interfacial Engineering and Materials Science** | **Molecular Biotechnology** | **Physical Process Technology** | **Environmental Biotechnology and Bioprocess Engineering** | **Cell and Tissue Engineering** |
|---|---|---|---|---|
| Hon.-Prof. Dr. Christian Oehr<br>Dr. Achim Weber | apl. Prof. Dr. Steffen Rupp<br>Dr. Anke Burger-Kentischer<br>Dr. Kai Sohn | Dipl.-Ing. Siegfried Egner<br>Dr. Thomas Scherer<br>Dr. Ana Lucía Vásquez-Caicedo | Dr.-Ing. Ursula Schließmann<br>Prof. Dr. Dieter Bryniok<br>Dr. Iris Trick | Prof. Dr. K. Schenke-Layland / Prof. Dr. Petra Kluger<br>Dr. Svenja Hinderer |
| Membranes<br>Particle-based Systems and Formulations<br>Plasma Technology and Thin Films<br>Polymeric Interfaces and Biomaterials | Infection Biology and Array Technologies<br>Functional Genomics<br>Molecular Cell Technologies<br>Industrial biotechnology<br>Analytics | Heat and Sorption Systems<br>Physico-chemical Water Technologies<br>Nutrient Managements<br>Aseptic Technologies<br>Prototype Development | Algae Technology<br>Bioprocess Engineering<br>Bioenergy<br>Integrated Water Management | Test Systems and Implants<br>Cardiovascular Systems, Biomaterials and Bioimaging<br>Attract Group “Organ-on-a-Chip” |

1/2016

# Institute of Interfacial Process Engineering and Plasma Technology IGVP

- Founded in 1994
- 92 employees
- € 3.22 million total budget (2015)
- 1456 $m^2$ area for laboratories, technical centers and offices



# Our innovation chain from fundamental research to industrial implementation

## Fundamental research

Universität Stuttgart
Institut für Grenzflächenverfahrenstechnik und Plasmatechnologie

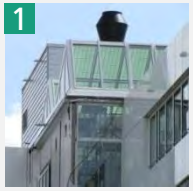
Eberhard Karls Universität Tübingen

Julius-Maximilians-Universität Würzburg

Hochschule Reutlingen
Reutlingen University

Technische Universität München

## Applied research

1 

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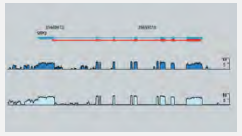
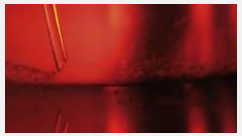
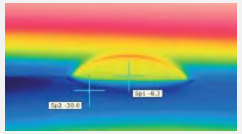
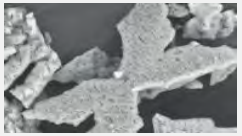
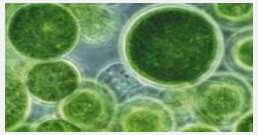
## Industrial implementation



BioEconomy Cluster




# Research highlights of Fraunhofer IGB

## Health

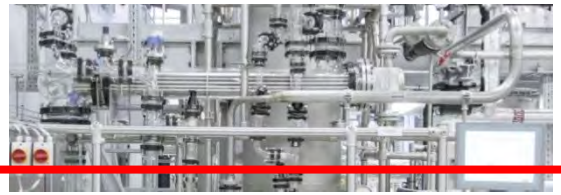
Cell-free “off the shelf“ heart valve by electrospinning

RIBOLUTION Platform for the identification of ncRNA-based diagnostics

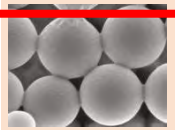
Screening for new immunmodulators with cell-based TLR-assay

Bioprinting ECM based bioinks for cartilage reconstruction

## Chemistry and Process Industry



Anti-icing coating Reduction of ice adhesion by more than 90 %



Polymeric adsorber particles for selective removal or concentration

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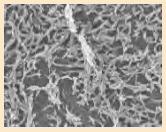
Lignocellulose biorefinery – Successful implementation on the pilot scale

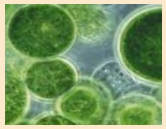
## Environment and Energy



Toxikomb – Detection of hazardous substances in drinking water

Molecular Sorting – Recovery of metals

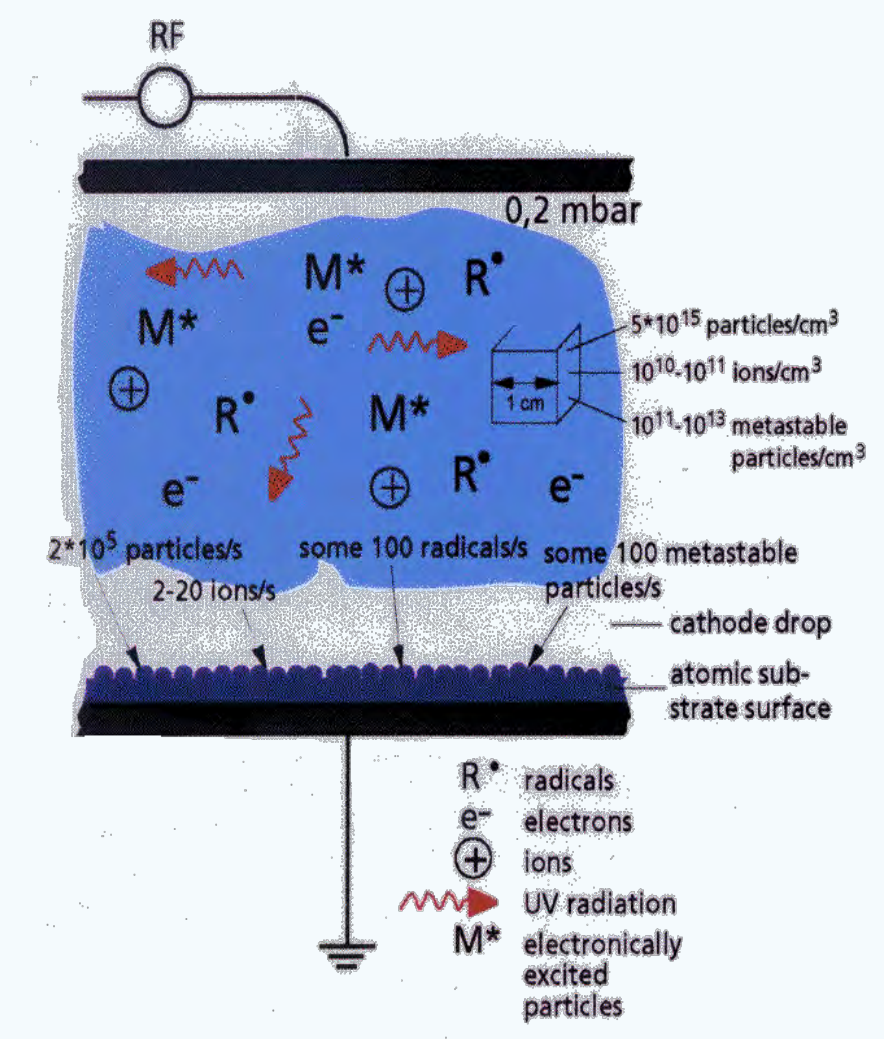
Membrane for energy conversion by osmosis



Microalgal starch as a fermentation substrate for biofuel production

# Interaction of Plasmas with Surfaces

Species generated in a glow discharge



# Tailored Surfaces

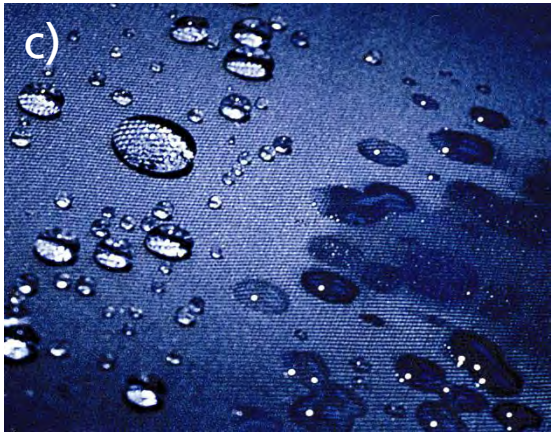
a) Scratch-resistant coating on polymers

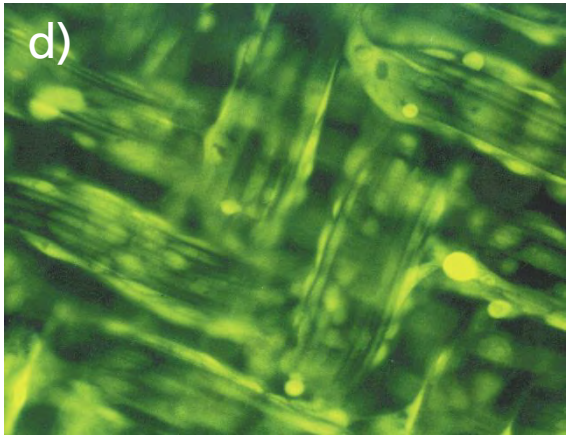
b) Solvent-resistant coating on polycarbonate

c) Hydrophobic finish of cotton/polyester

d) Treatment of textile substrates for enhanced cell growth





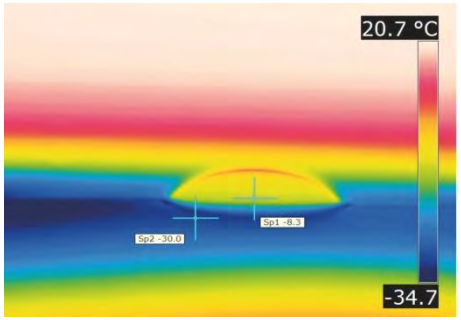



# Anti-ice coatings using plasma functionalized surfaces

## Development of anti-ice coatings

- Icing of wind power plants, aircraft or solar cells entail greater expense
- Water-repellent micro- and nanostructured coatings on polymer films using plasma technology
- Minimization of ice formation on the surfaces by more than 90 percent (compared with the reference)






Partners: EADS Innovation Works, CEROBEAR GmbH, PINK GmbH, ROWO Coating Gesellschaft für Beschichtungen mbH, Bremen Center for Computational Materials Science (BCCMS) at the University of Bremen.

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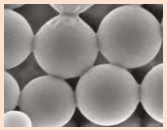

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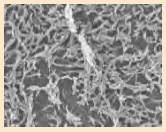

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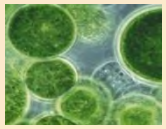

Microalgal starch as a fermentation substrate for biofuel production



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# FRAUNHOFER CENTER FOR CHEMICAL-BIOTECHNOLOGICAL PROCESSES CBP



Fraunhofer CBP

# Challenges for the transfer of petrochemical-based manufacturing into renewable-based manufacturing


- Feedstock availability and logistics
- Feedstock composition
  - Feedstock pretreatment
  - Process development and scale-up
  - Resource efficiency and recycling
- Integration in value chains
- Consumer acceptance
- Manufacturing costs



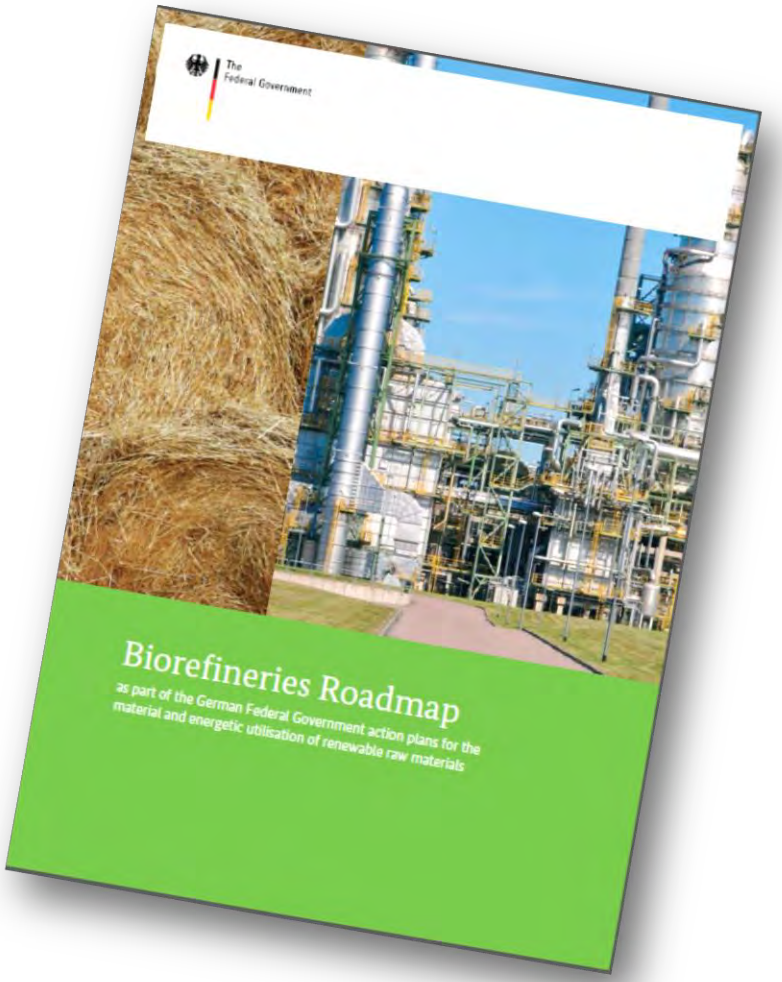

Fraunhofer CBP

# Types of biorefineries

## What is meant by a biorefinery?

A biorefinery is characterised by an explicitly integrative, multifunctional overall concept that uses biomass as a diverse source of raw materials for the sustainable generation of a spectrum of different intermediates and products (chemicals, materials, bioenergy/biofuels), allowing the fullest possible use of all raw material components. The co-products can also be food and/or feed. These objectives necessitate the integration of a range of different methods and technologies.

1. Sugar biorefinery and starch biorefinery
2. Vegetable oil biorefinery and algal lipid biorefinery
3. Lignocellulosic (cellulose, hemicellulose and lignin) biorefinery and green biorefinery
4. Synthesis gas biorefinery
5. Biogas biorefinery

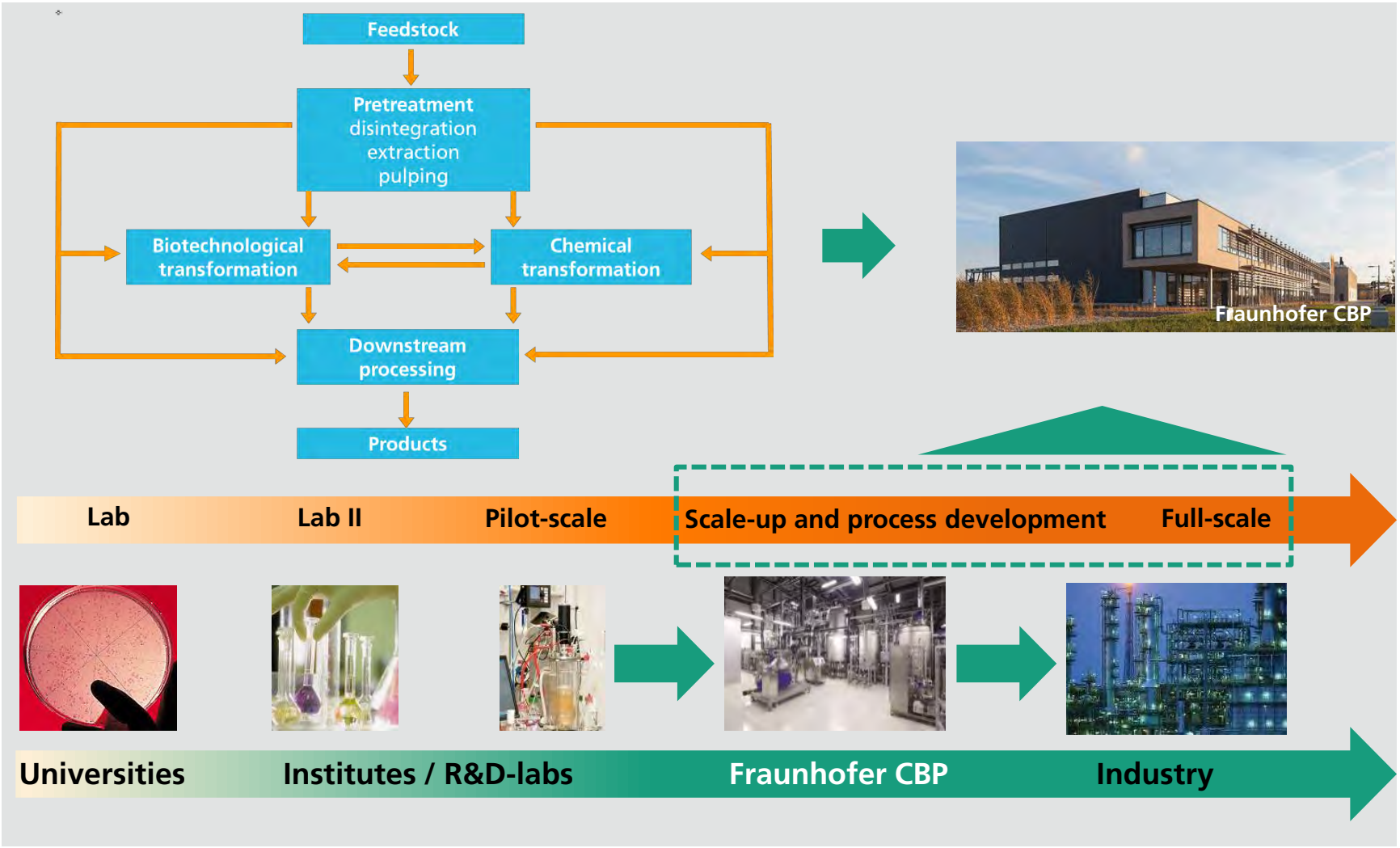



DECHEMA
Gesellschaft für Chemische Technik und Biotechnologie e.V.



Fraunhofer CBP

# From laboratory to industrial scale






Fraunhofer CBP

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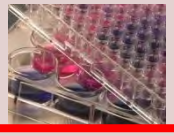

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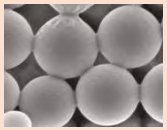

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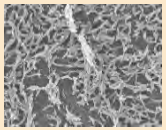

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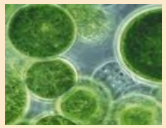
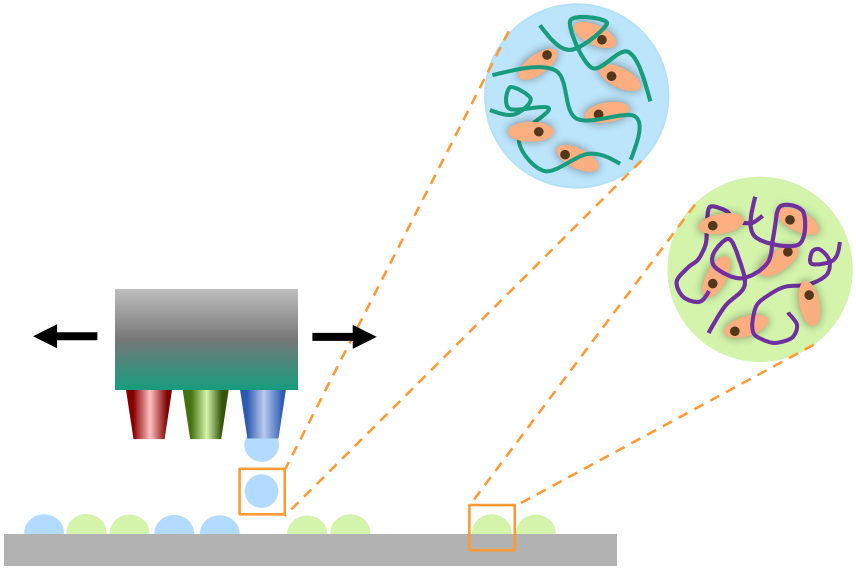


Microalgal starch as a fermentation substrate for biofuel production

# Bioprinting

Definition: "…use of **material transfer processes** for patterning and **assembling biological and biologically relevant materials** - molecules, cells, tissues, and […] biomaterials - …to **accomplish** one or more **biological functions**".

[Mironov, V., Reis, N. & Derby, B. Review: bioprinting: a beginning. *Tissue engineering* 433 **12**, 631-634, (2006)].



# Bio-ink development

**„Bioink“ (hydrogel-precursor)**

- viscosity, gelling behaviour
- crosslinkability
- cytocompatibility

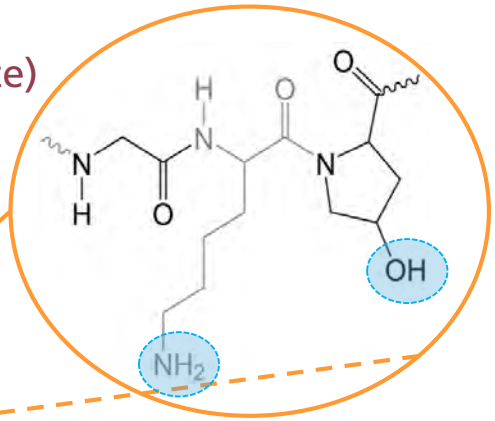
ECM derived biopolymer

**3D hydrogel matrix**

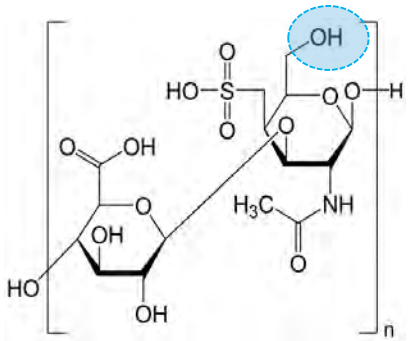
- cytocompatibility
- tissue-specific stiffness, swellability
- stabilized cell-function

# Crosslinkable and printable biopolymers

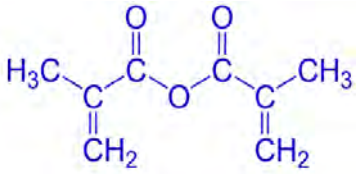
Gelatin
(collagen derivate)




Glykosamino glykanes
(Chondroitin sulfate,
hyaluronic acid)

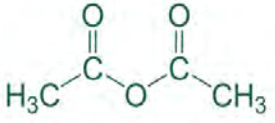



1. Crosslinkable biopolymers:
GM, CSM, HAM




Methacrylic acid
anhydride

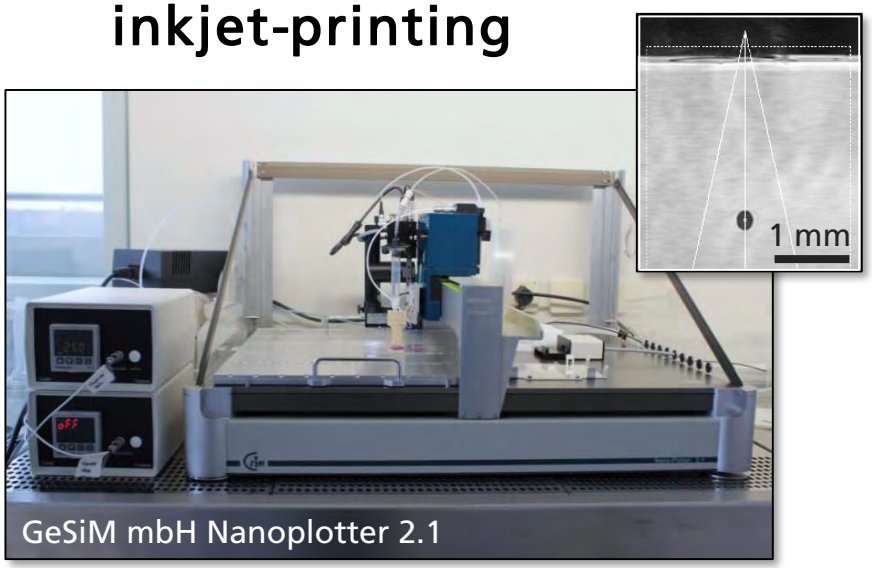
2. Printable gelatin – masking
GMA




Acetic acid
anhydride

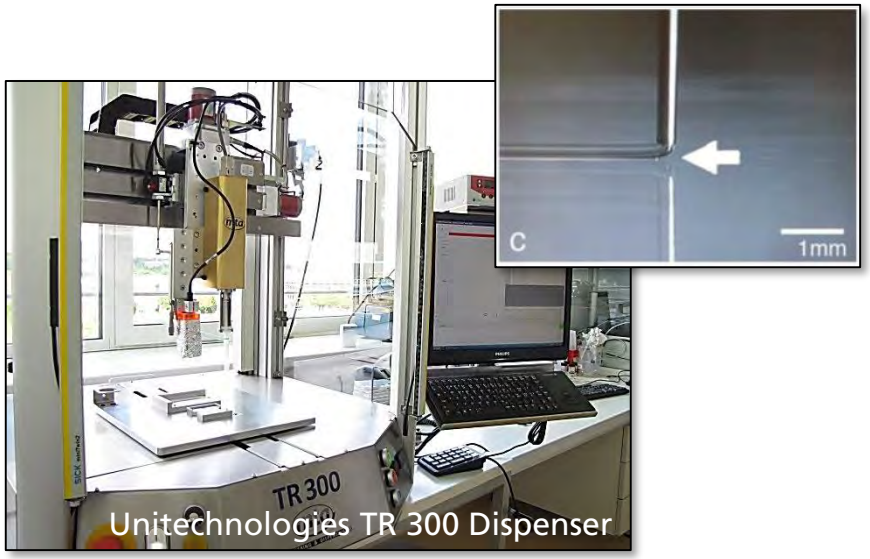
# Printers

## Drop-on-demand inkjet-printing




- Piezo *drop-on-demand* nanopipette
- DIsposable cartrigdes with heater
- Drop volume: 400-800 pL
- UV-source

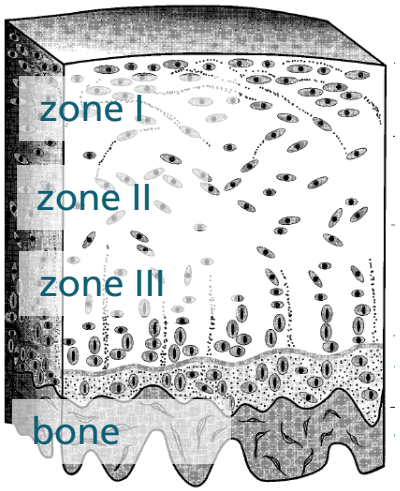
## Dispensing



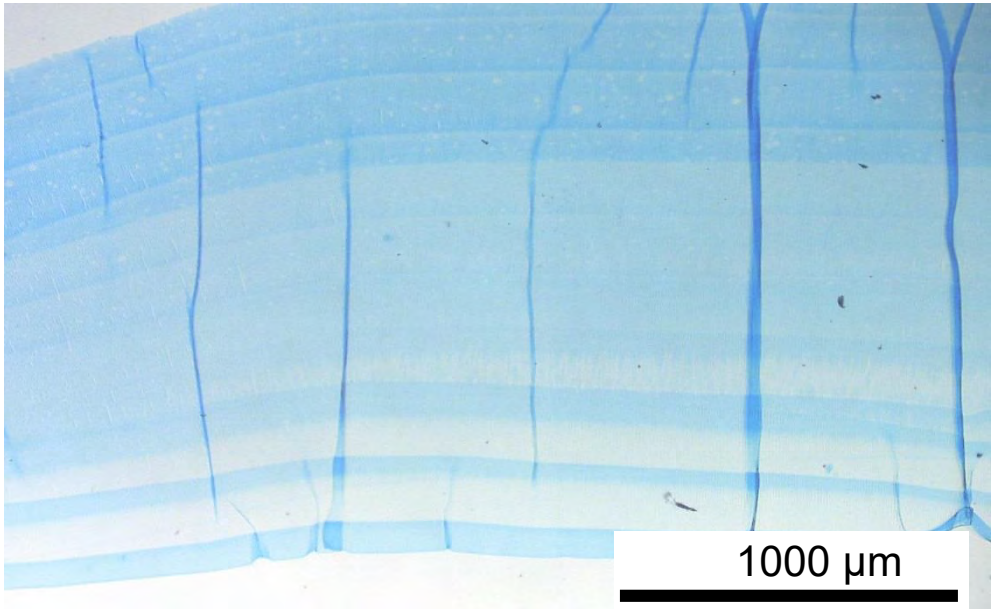

- Pneumatic dispenser
- Disposable pipettes
- Min. dispensing volume: 1 µL
- UV-source

# ECM based bioinks for cartilage reconstruction

- **Dispensing**
  - Layer-by-layer assembly gradients
  - Integration of chondrocytes




**Zonal structure of articular cartilage**




**Gradient of chondroitin sulphate by dispensing** (alcian blue staining)

*Hoch, Stier, Borchers: in preparation (2016)*

# Contact

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