Laser printing of functional materials and microdevices

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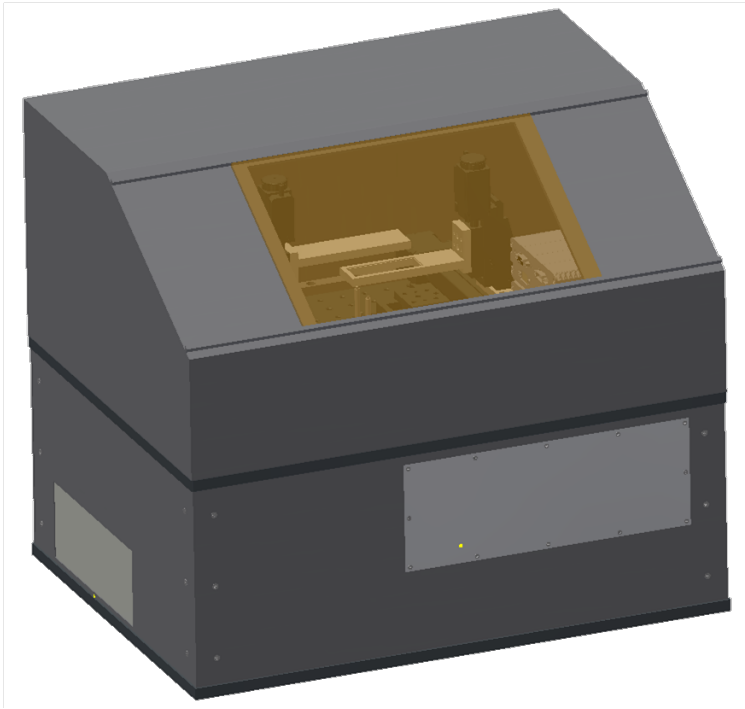
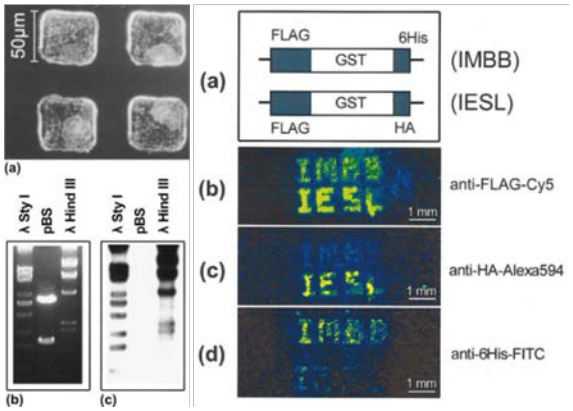
Concept

Make laser printing
an enabling technology
for advanced
Biotechnological and electronic
applications.



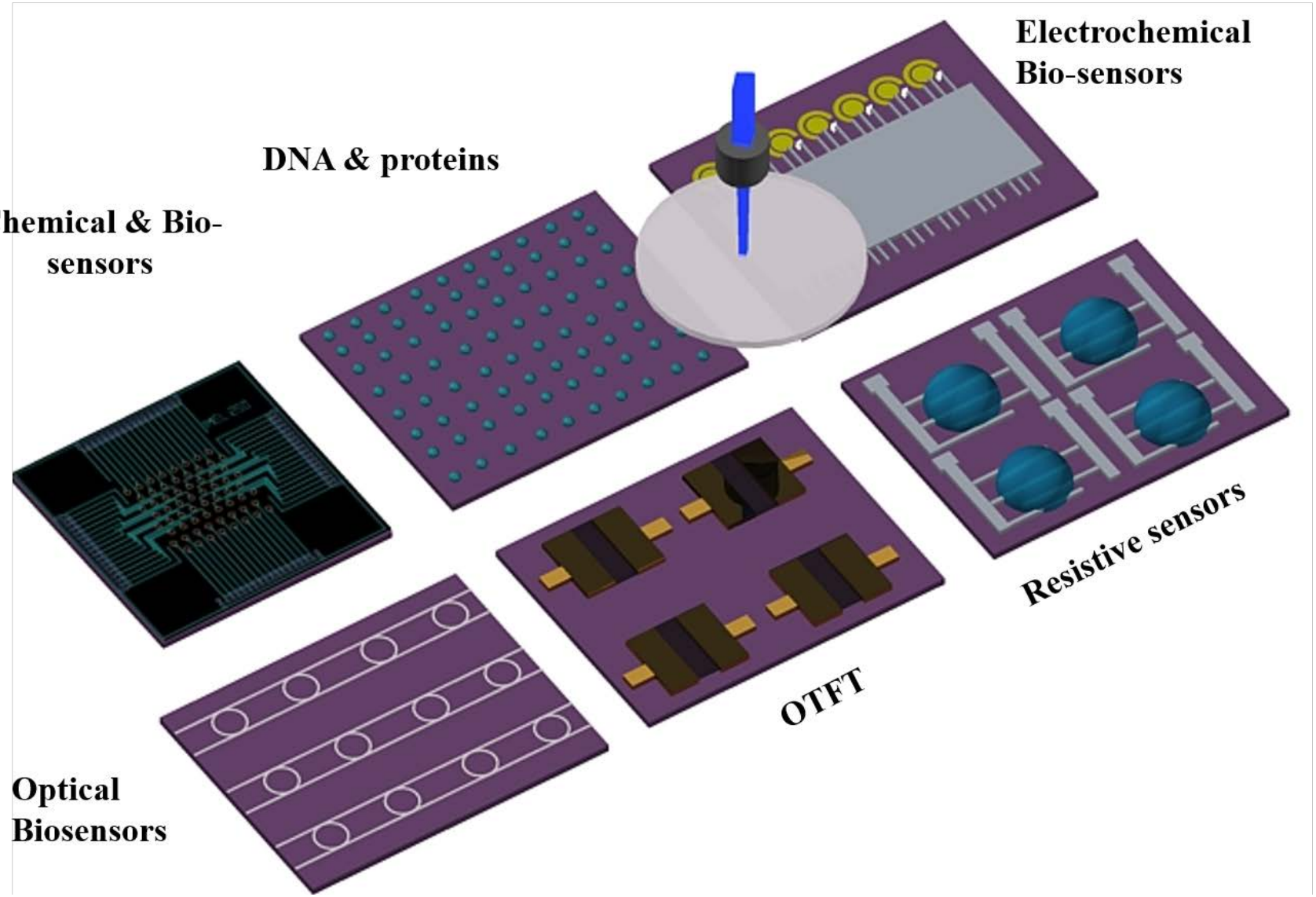
DNA printing



Strong Background

In 2005, for the first time in literature DNA laser printing achieved by I. Zergioti at FORTH

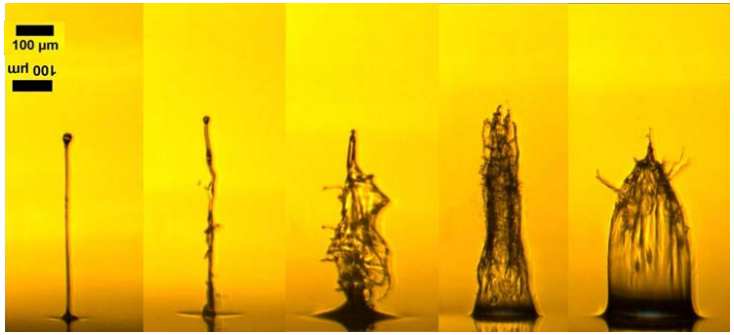
I. Zergioti, et al. APL, 163902 (2005)


Electrochemical
Bio-sensors
DNA & proteins
Chemical & Bio-
sensors
Resistive sensors
OTFT
Optical
Biosensors

Laser Induced Printing

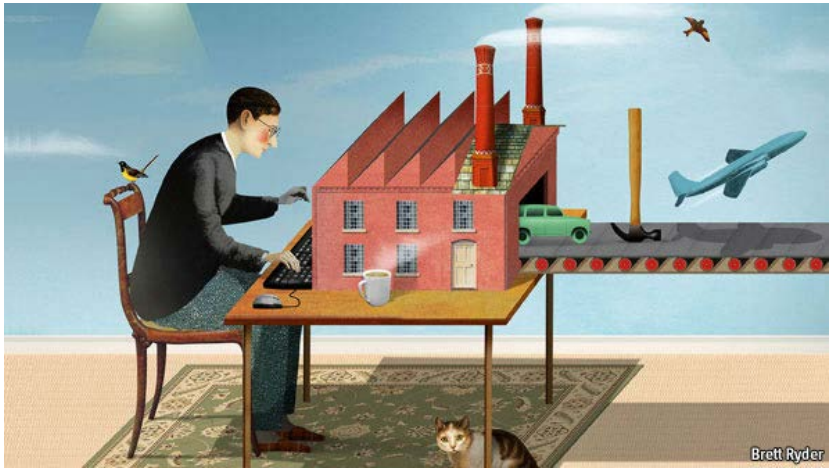
LIP

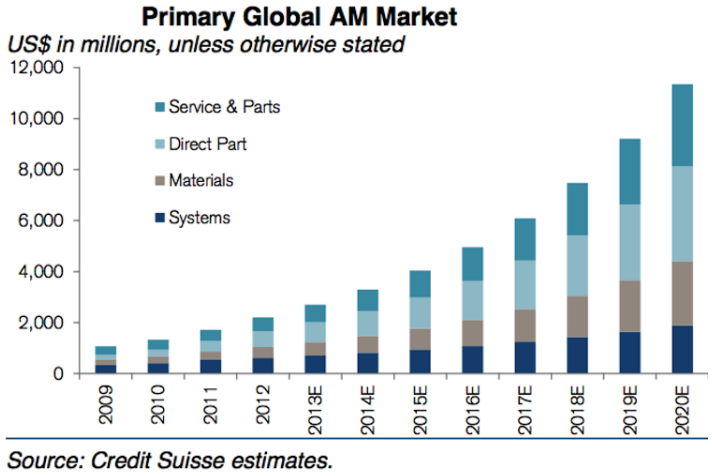
- Printing in solid and liquid phase.
- Printing of organic, inorganic, biological materials.
- Spatial resolution down to a few μm in liquid phase and sub-μm in solid phase.
- Tunability in spatial resolution and impact pressure.



Additive Manufacturing – The new industrial revolution

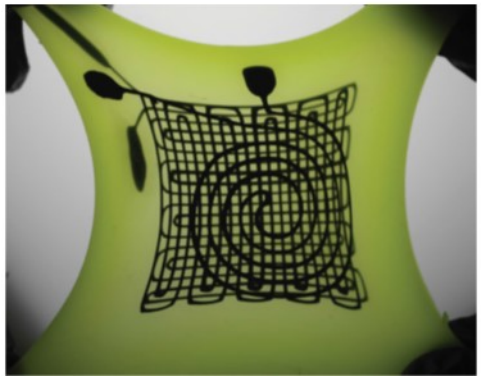
"*Additive Manufacturing has the potential to revolutionize the way we make almost everything*" US President Barack Obama, 2013, at National Additive Manufacturing Innovation Institute (NAMII) in Youngstown, Ohio





Εύκαμπτα Κυκλώματα

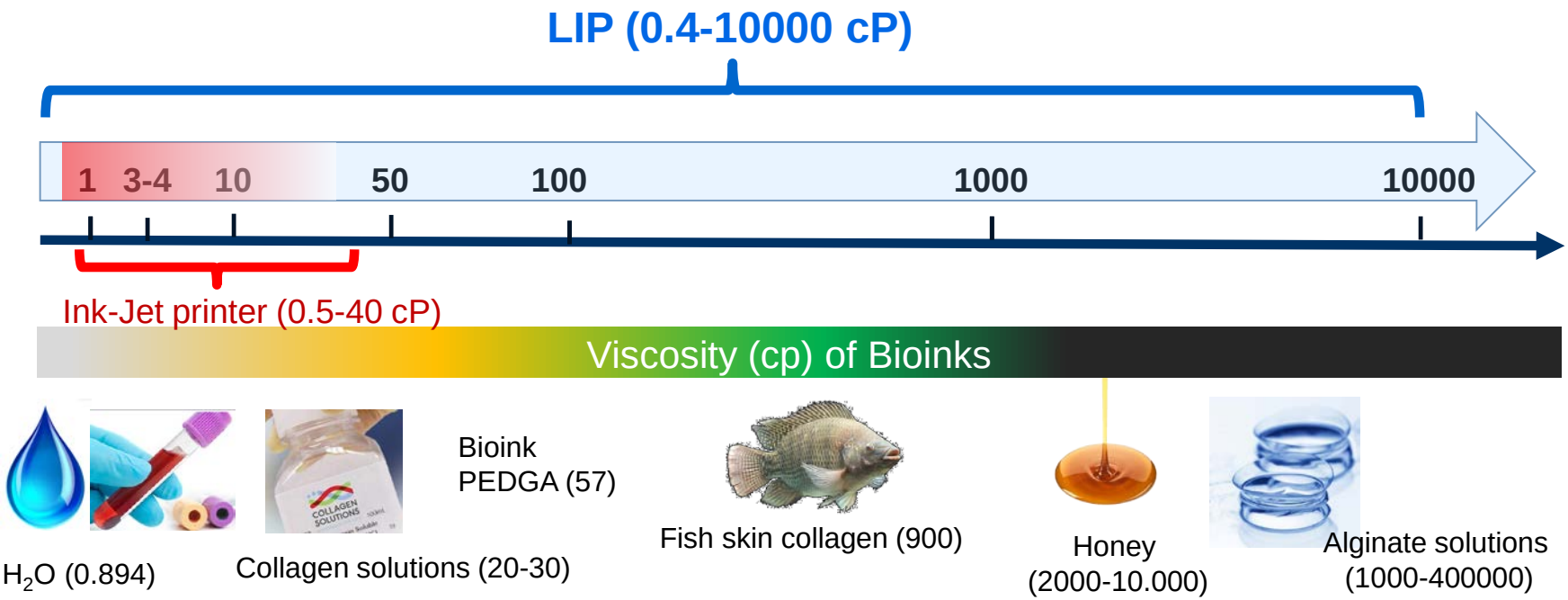
Εκτάσιμοι Αισθητήρες



Οθόνες Αφής

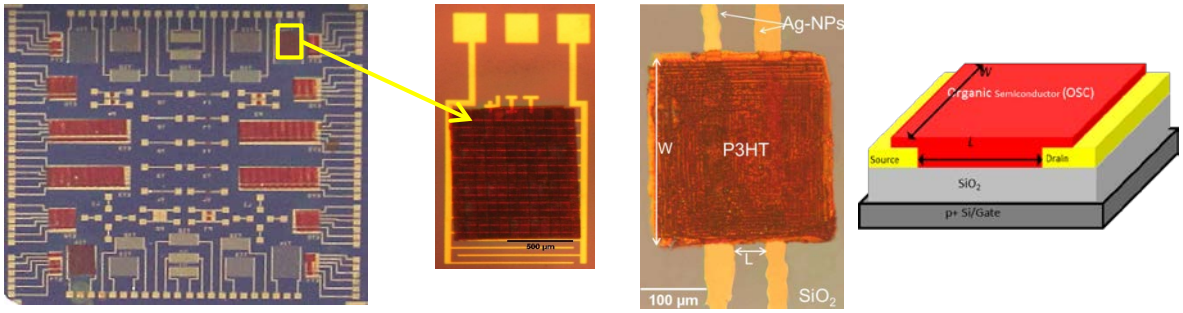
LIP advantages and innovation

- Innovation on the direct printing process
- Drop-on-demand printing, non-contact printing
- Compatible with a wide range of materials
- No limitations in materials viscosity (0.4–10000cP)
- No use of nozzles, no additives

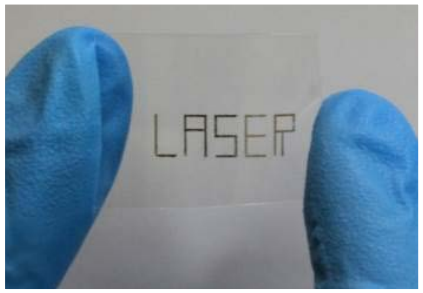


Target Applications: Printed and Flexible Electronics

Printing of organic semiconductors - Organic Transistors

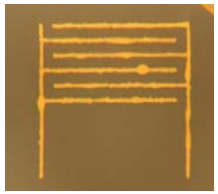


2D and 2.5D patterns printed on flexible substrates

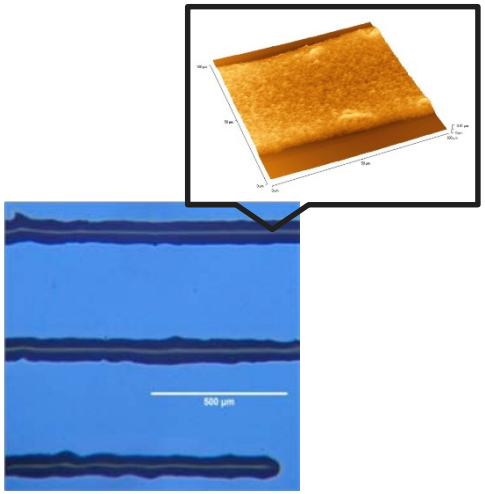


Printing of metal Nanoparticle inks

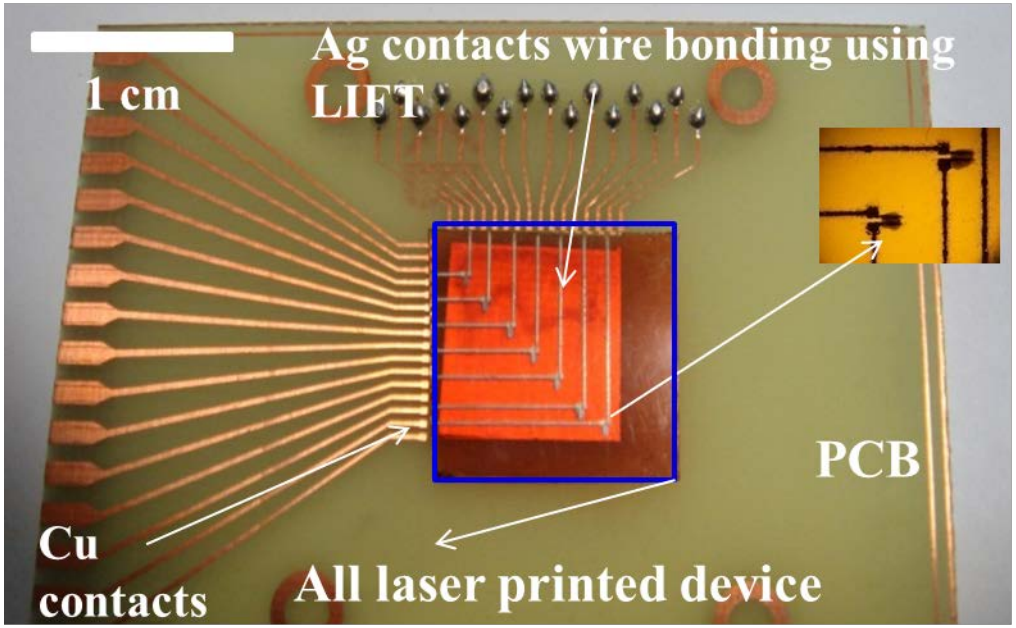
Silver Inks

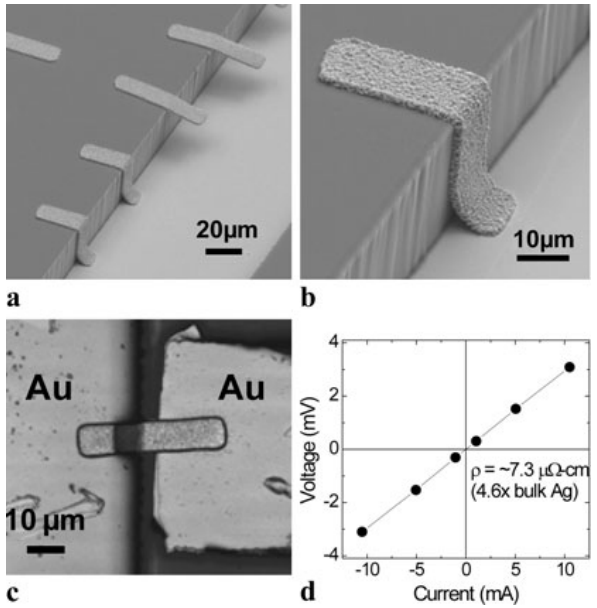


Copper Inks



Electronic circuit repair



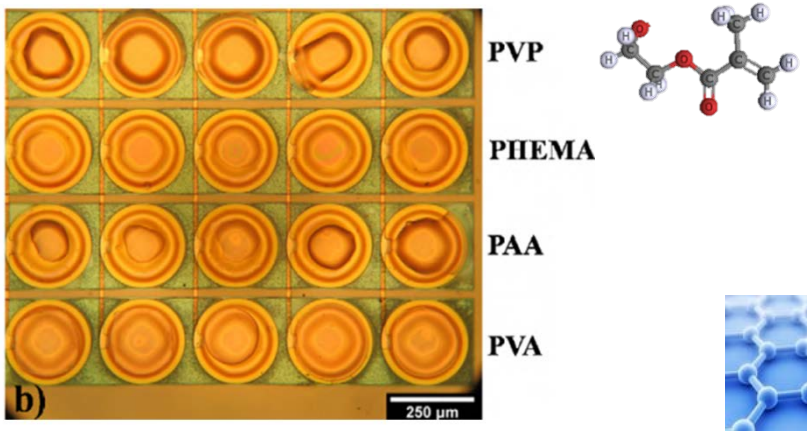


H. Kim · M. Duocastella · K.M. Charipar ·R.C.Y. Auyeung · A. Piqué, Appl Phys A (2013) 113:5–8

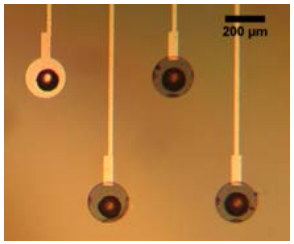
- Wire bonding and 3D printing of inks and pastes
- Selective laser ablation for short circuit repair

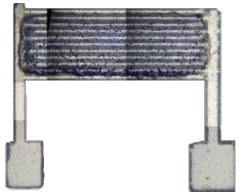
Organic and 2D materials

Polymer printing for chemical capacitive sensors

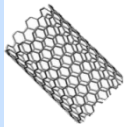


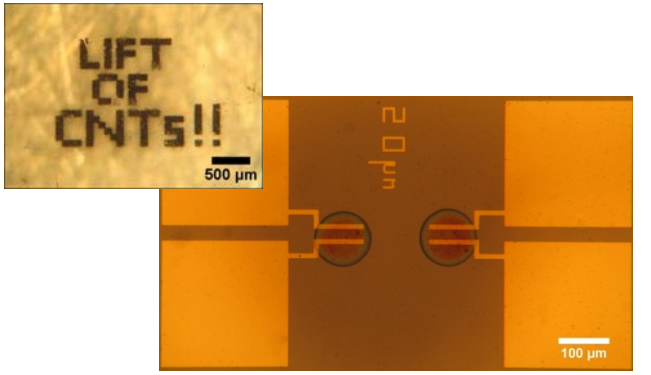
V. Tsouti, C. Boutopoulos, D. Goustouridis, I. Zergioti, P. Normand, D. Tsoukalas, S. Chatzandroulis, Sensors and Actuators B , vol. 150, pp. 148–153, 2010.

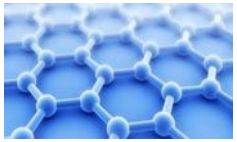




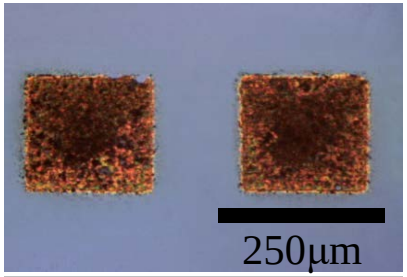
Printing of polymer matrix with embedded CNTs







Printing of graphene and graphene oxide



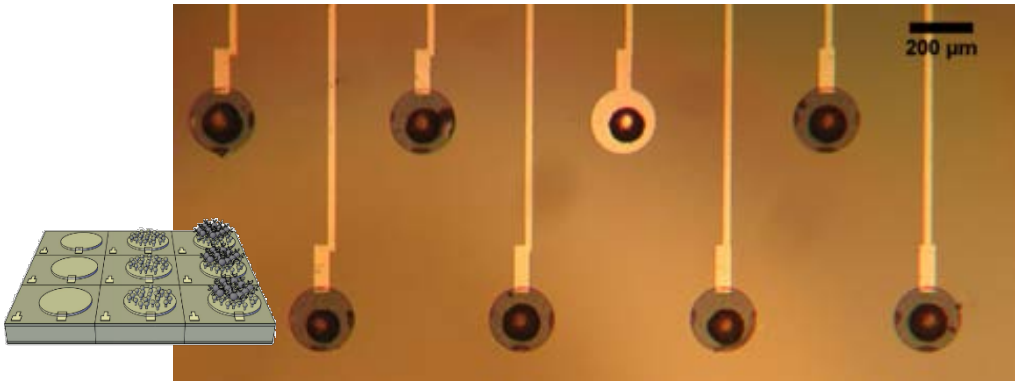
Solid Phase

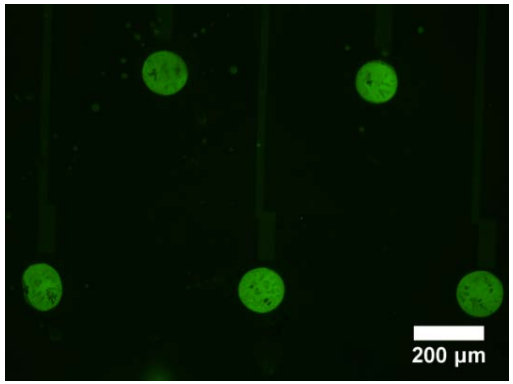
Liquid phase

Target Applications

Biomolecules printing- Biosensors

- Biopatterns of DNA, enzymes, antibodies, aptamers, etc.
- Precise, direct immobilization of biomaterials on sensors.
- Bio-printing without additives.
- 100% viability of the biomaterials.

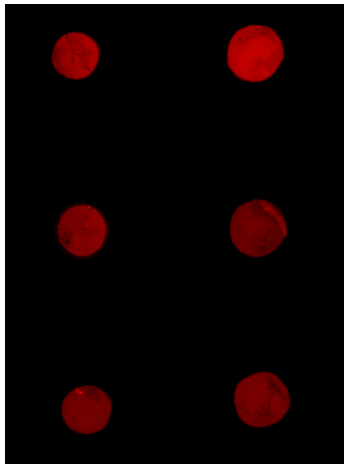


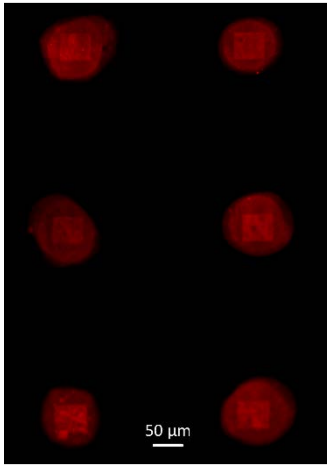


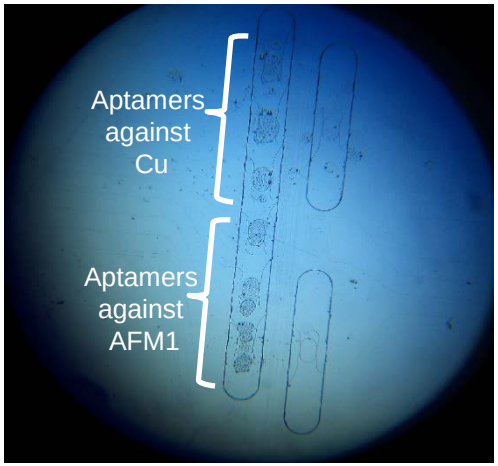
Target Applications

Biomolecules printing (DNA, enzymes, antibodies, aptamers)

- Non-contact laser induced click chemistry
- Simplifying complicated, multi-stepped immobilization chemical processes.

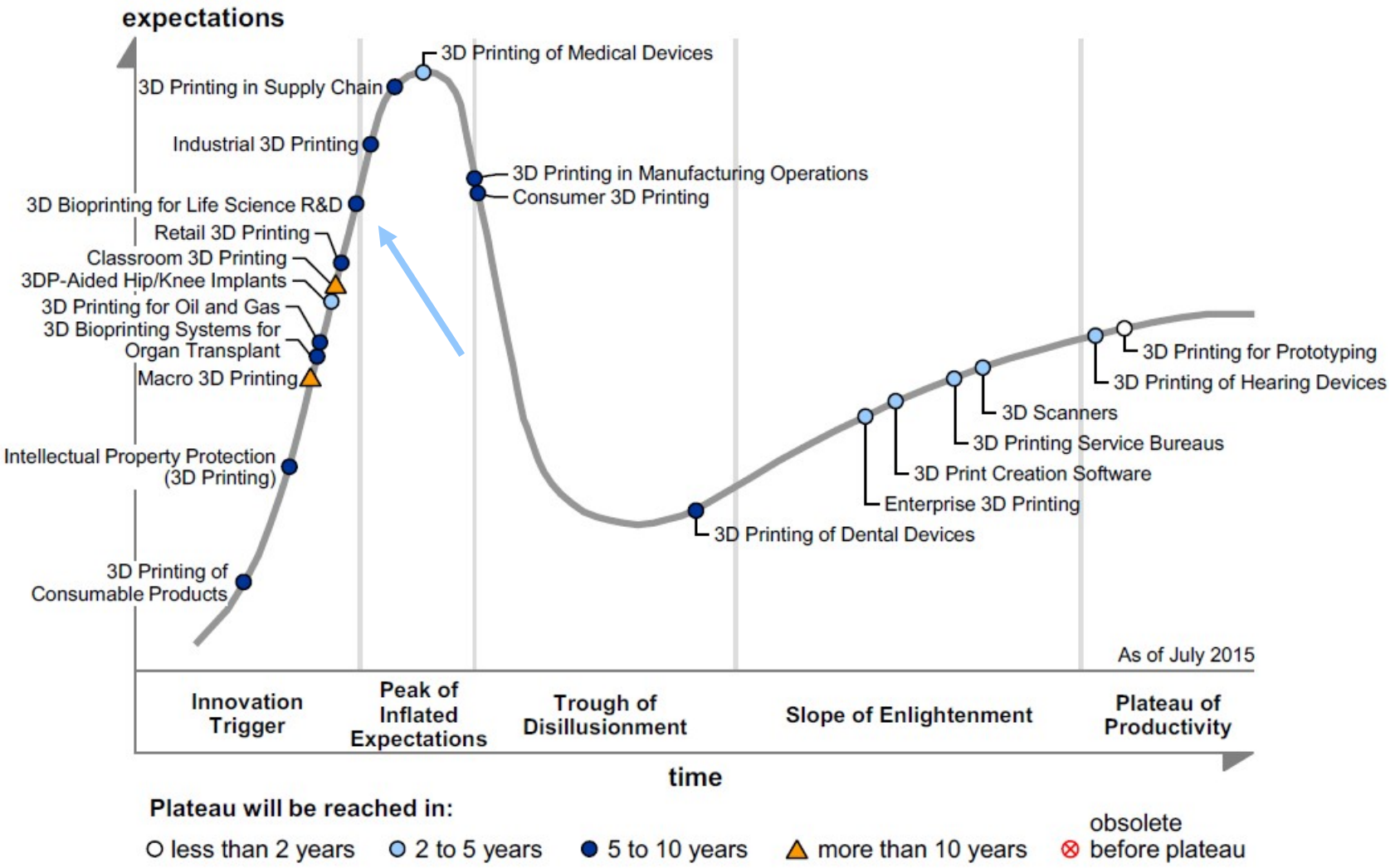






3D printing impact and potential

Figure 1. Hype Cycle for 3D Printing, 2015



Source: Gartner (July 2015)

Potential Beneficiaries

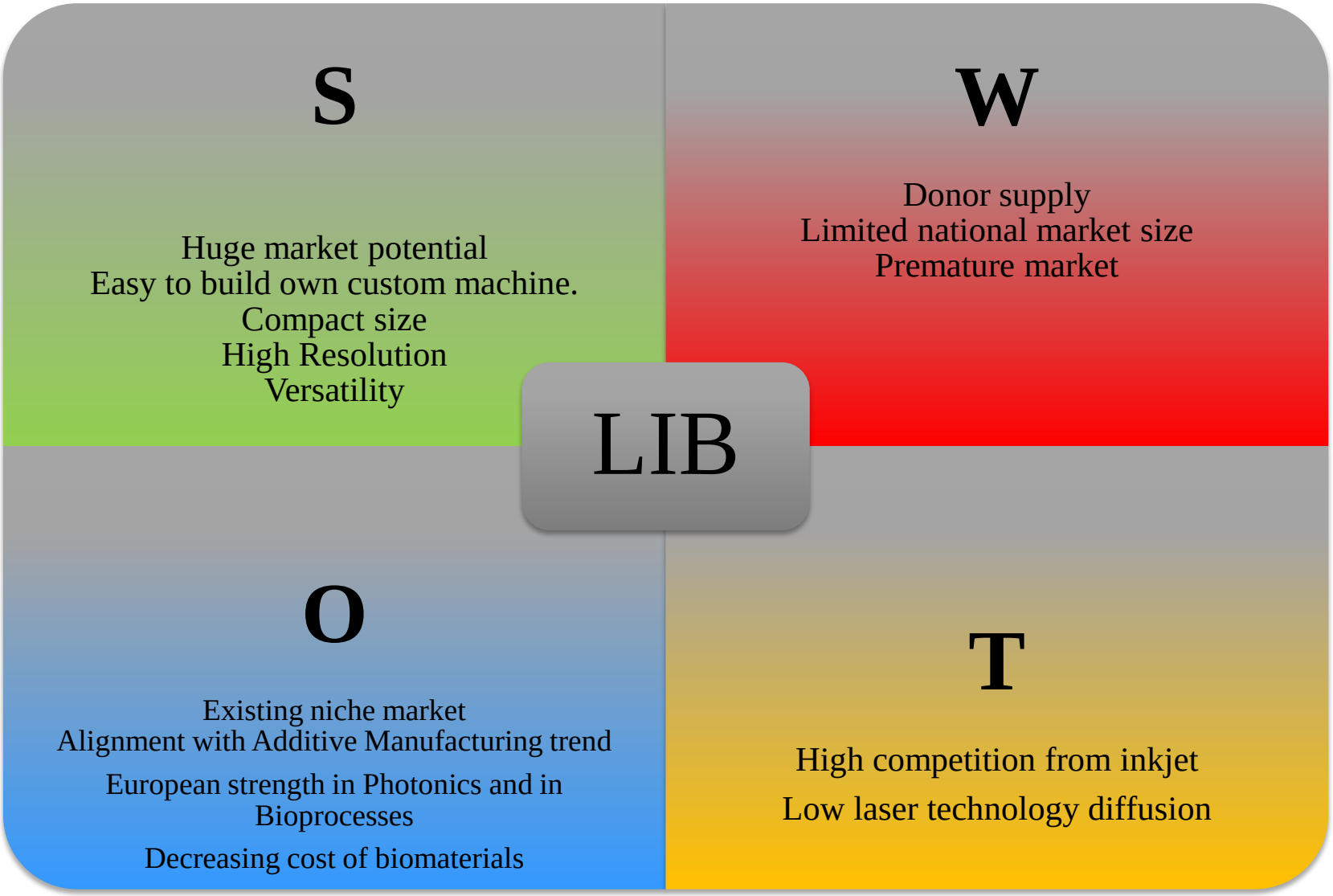
R&D centers

Universities

Pharmaceutical Industry

Hospitals

SWOT


S
Huge market potential
Easy to build own custom machine.
Compact size
High Resolution
Versatility
W
Donor supply
Limited national market size
Premature market
LIB
O
Existing niche market
Alignment with Additive Manufacturing trend
European strength in Photonics and in Bioprocesses
Decreasing cost of biomaterials
T
High competition from inkjet
Low laser technology diffusion

Business model

Key Activities

Develop new printing systems
Provide R&D services

Key Resources

Intellectual Property
Human resources
Prior experience

Channels

Direct Sales
Trade shows
International conferences
Peers' network

Cost Structure

Consumables & parts
R&D Personnel
Direct Sales &Travel
Lab equipment

Revenue Streams

System Sales (B2B)
R&D Services

Customers

R&D Centers
Hospitals
Universities
Pharmaceutical Industry

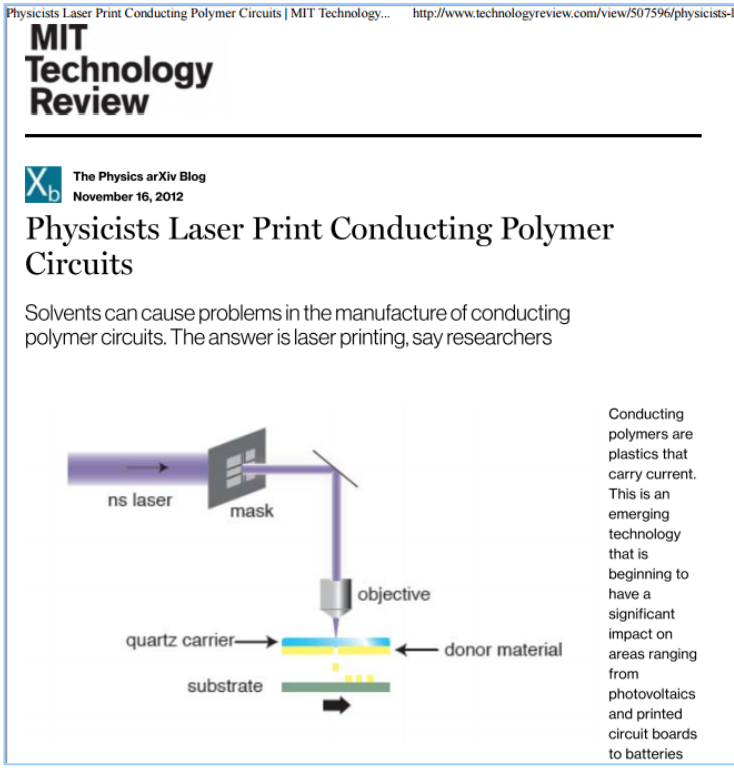
Our Technology and Intellectual property

1. **UK provisional Patent application Appl. no. 1522165.8.**

Method For Activating Click Reactions Through Laser Induced Forward Transfer of Molecules

M. Massaouti, M. Chatzipetrou, A.K. Schütz-Trilling, L. Scheres, M.M. Smulders, H. Zuilhof, I. Zergioti, submitted at the UKPO.

2. New patent application is under preparation.


Physicists Laser Print Conducting Polymer Circuits | MIT Technology... http://www.technologyreview.com/view/507596/physicists-l

MIT Technology Review

The Physics arXiv Blog
November 16, 2012

Physicists Laser Print Conducting Polymer Circuits

Solvents can cause problems in the manufacture of conducting polymer circuits. The answer is laser printing, say researchers

Conducting polymers are plastics that carry current. This is an emerging technology that is beginning to have a significant impact on areas ranging from photovoltaics and printed circuit boards to batteries

2nd award at the 3rd competition «Η ΕΛΛΑΔΑ ΚΑΙΝΟΤΟΜΕΙ!», Eurobank-SEV 2016

Competition
similar laser printing process

Fraunhofer ILT

Biomolecules laser printing

No relevant patents

poietis
make tissues real

Living tissue laser printing

Patent no: WO2011107599A1

Orbotech

LIFT patent owner

Patent No: US 7014885 B1

The Team

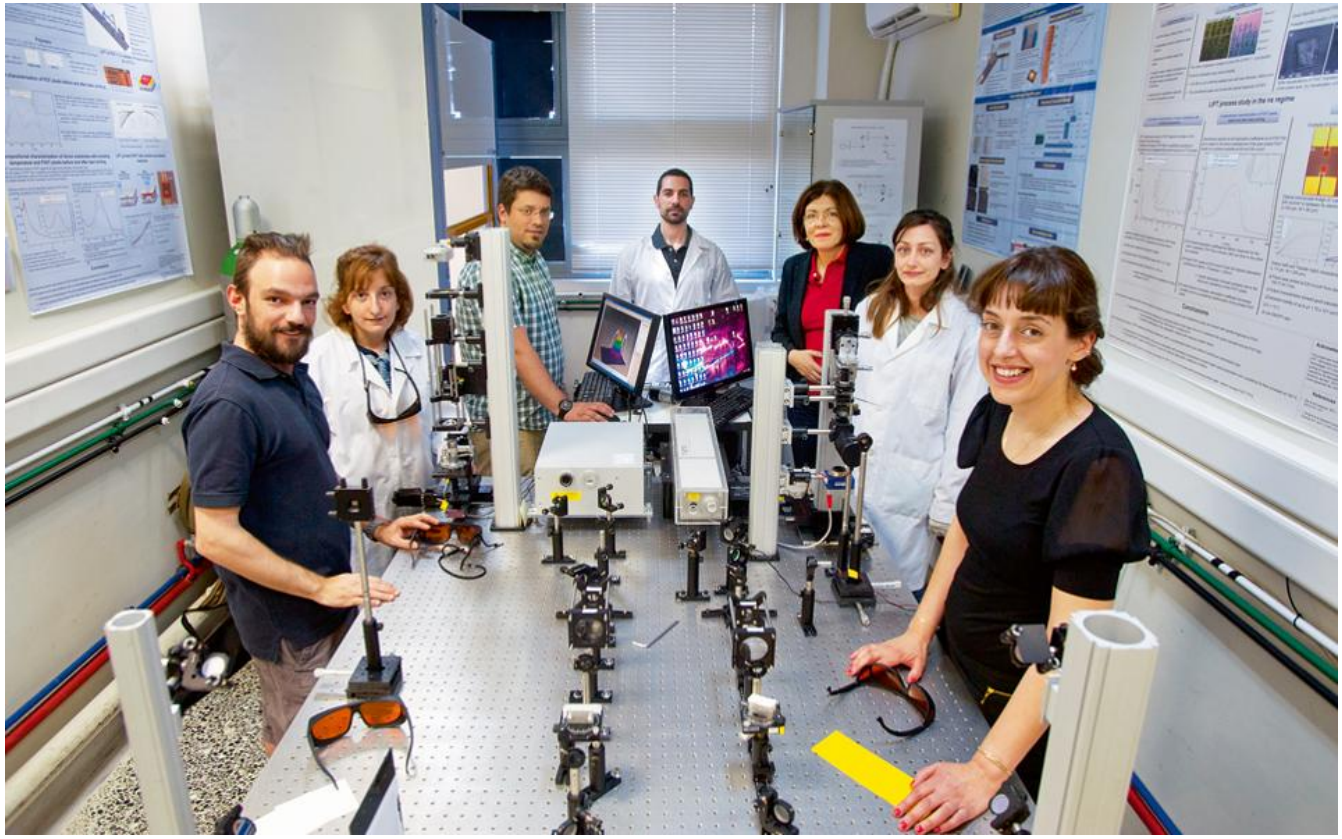
Dr. Filimon Zacharatos
PhD in Nanotechnology
3 years experience on Laser Printing

Dr. Maria Massaouti
PhD in Physical-chemistry
3 years experience on laser printing

John Theodorakos
Msc, Laser Engineer
3.5 years experience on Laser Printing

Prof. I. Zergioti
20 years on Laser Printing

NTUA: Laser Materials Micro-processing Group



HiperLAM

LaserMicroFAb

BioFAs
Micro-ring resonator-based biophotonic system for food analysis

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