

5th BioNanoNet Member Welcome Webinar

Advanced Manufacturing Laboratory

Carlos Sánchez Somolinos



Advanced Manufacturing Laboratory





Advanced Manufacturing Laboratory

GROUP MEMBERS

Group Leader



Sánchez-Somolinos

Project Manager



Atrian

Lab Manager



López-Valdeolivas

PhD Students



Ceamanos



Javadzadeh



Montesino



Espíndola



Sartori



Hernández



- + Largest Public Research Organization in Spain and 3rd in Europe
- + 13,000 employees
- + 20% of Spanish R&D output
- + 120 Research Centres in Spain



From basic research to technological development around 8 areas

- Humanities & Social Sciences
- Biology & Biomedicine
- Natural Resources
- Agricultural Sciences
- Physical Science & Technology
- Material Science & Technology (11 research centres)**
- Food Science & Technology
- Chemical Science & Technology





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Scientific Objective

Multidisciplinary approach

Design of materials and systems

Chemical structures and a 3D model of a cylindrical component.



Processing

3D model of a curved component being processed by a nozzle.



Functional Polymeric Systems

Microscopic image of a yellow ring-like structure on a grid.



Optics

Biomedicine

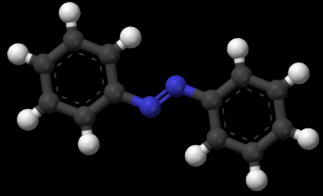
Soft Robotics



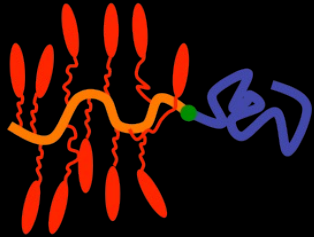
AML

Advanced Manufacturing Laboratory

Functional Organic Materials



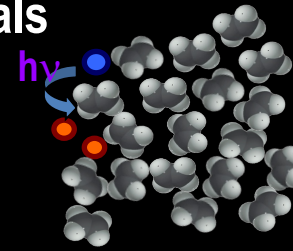
Functional molecules,
polymers and nano-objects



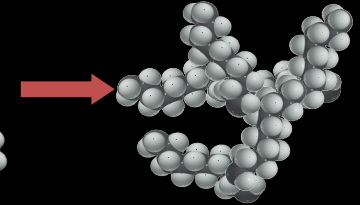
Block Copolymers



Liquid Crystalline Materials



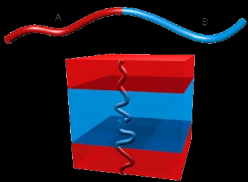
Low molecular weight.
Soluble



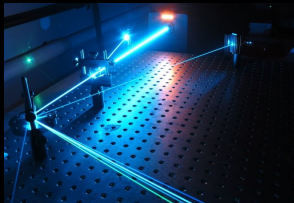
High molecular weight.
Insoluble

Photopolymers

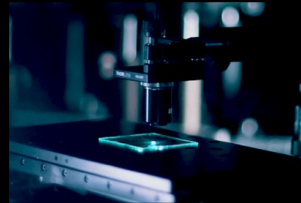
Advanced Manufacturing Tools



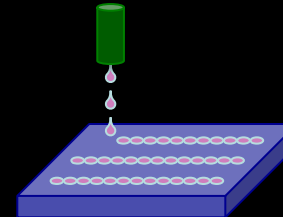
Self-Assembly



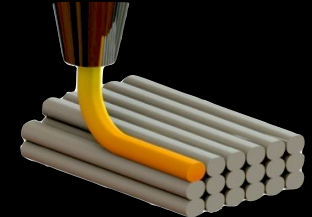
Mask and Holographic
Photolithography



Direct Laser Writing

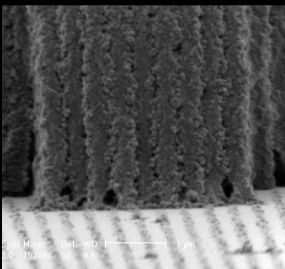


Inkjet

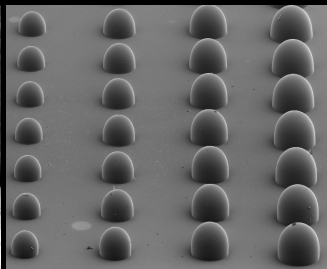


3D printing

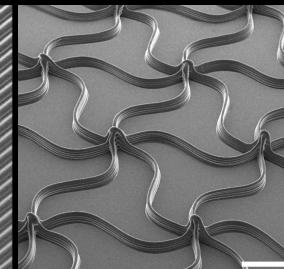
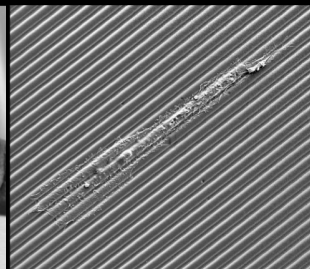
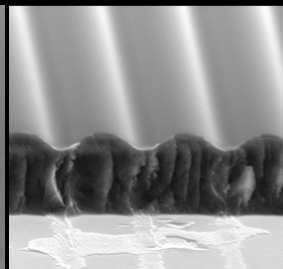
Controlled Morphologies towards Functional Polymeric Systems and Applications



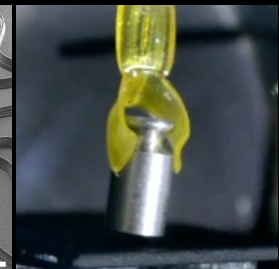
Optics



Biomedicine



Soft Robotics



Soft Actuators

External stimulus

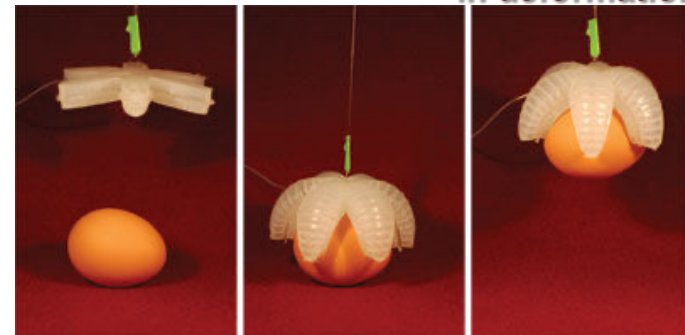


Polymeric systems that deform in a prescribed fashion in response to an external stimulus: light, heat,...

Hard vs Soft Robotics



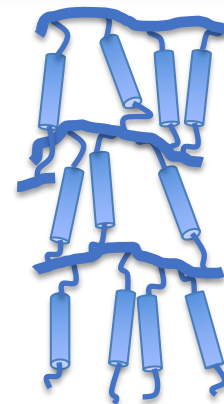
Flexibility and adaptability in deformation



D. Rus, et al Nature 2015, 521, 467

Implementation of soft robotic functions with potential use in the handling of small and delicate objects, soft tissues

Reactive mesogens



Liquid crystalline
polymeric networks

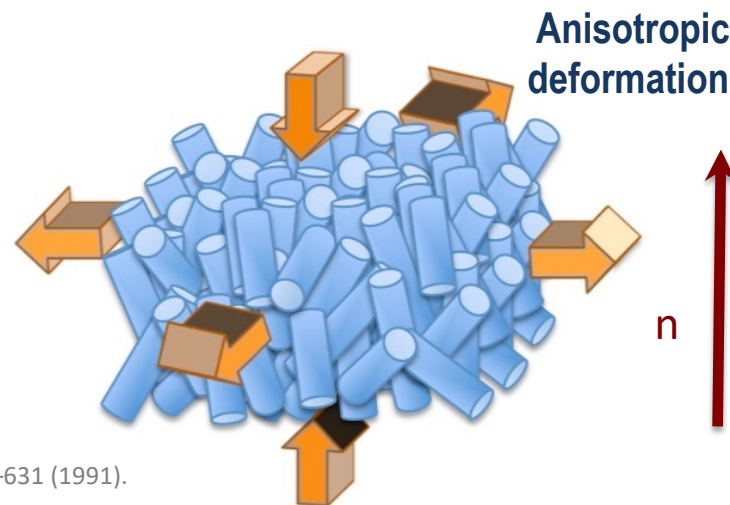
n



External stimulus



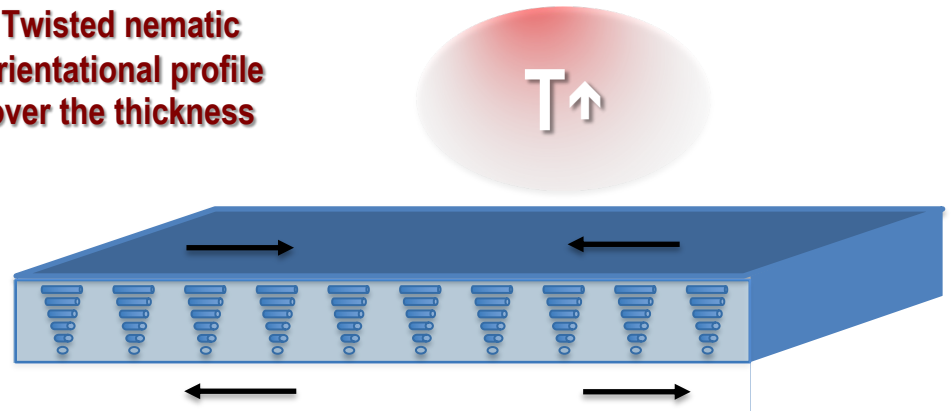
Increment of
mesogenic disorder



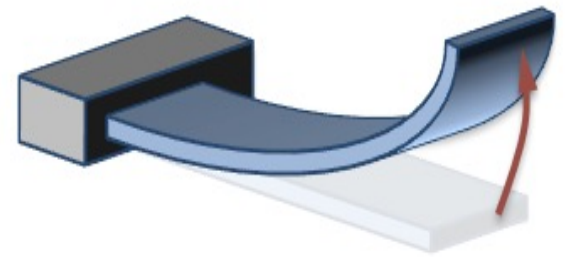
n

D. J. Broer and G. N. Mol, Polym. Eng. Sci., 31, 625–631 (1991).

Twisted nematic orientational profile over the thickness



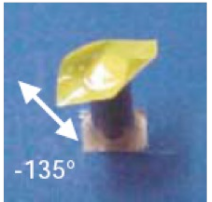
HEAT



G.N. Mol et al, Adv. Funct. Mater. 15, 1155 (2005).

Engineering the director over the thickness allows deformation of the cantilevers with homogenous stimulus

Photoactuated cantilevers and gripping devices



Y.Yu et al. Nature 425, 145 (2003)



S. Serak et al, Soft Matter 6, 779 (2010)



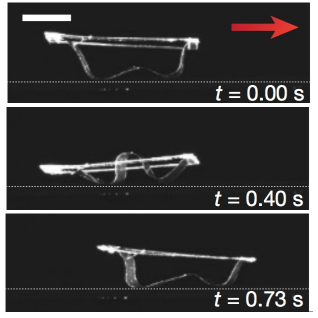
O.M. Wani et al, Nat. Comm 8, 15546 (2017)

Artificial cilia

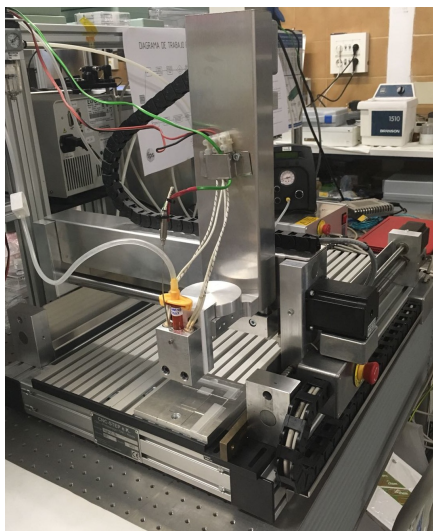


C. L. van Oosten et al, Nat Mater. 8, 677 (2009)

Walking devices



A. H. Gelebart et al., Nature. 546, 632 (2017).

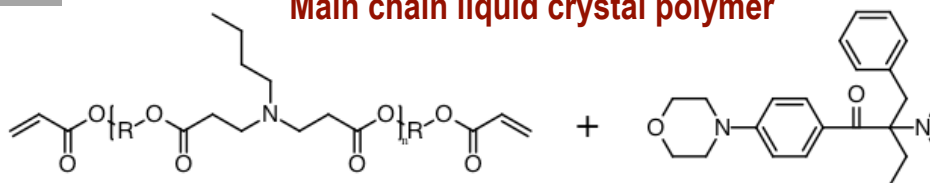


3D Printing platform



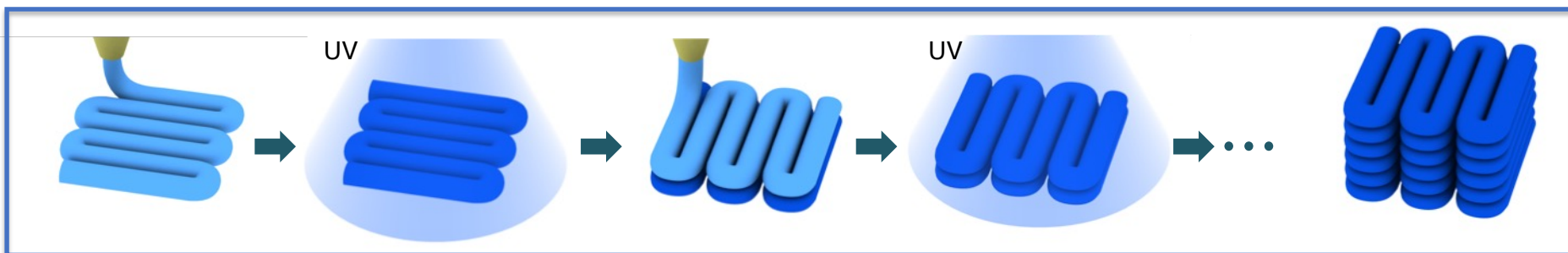
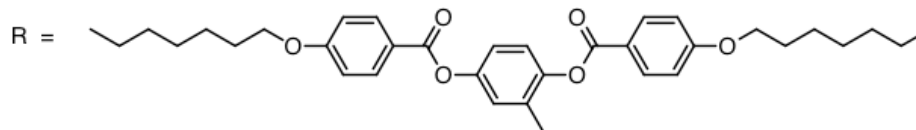
López Valdeolivas

Main chain liquid crystal polymer



Macromer

Photoinitiator



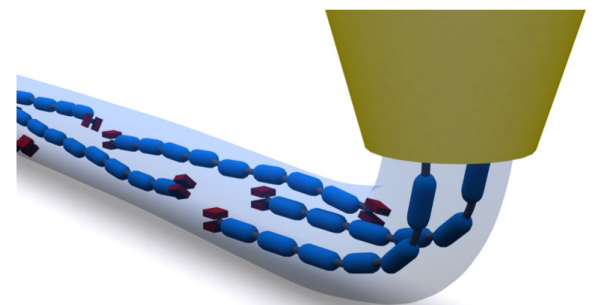
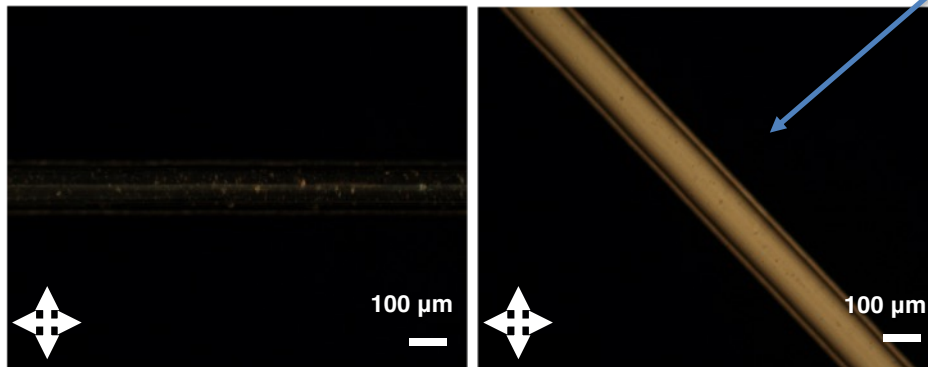
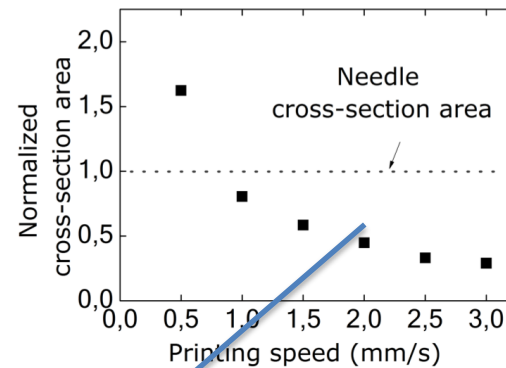
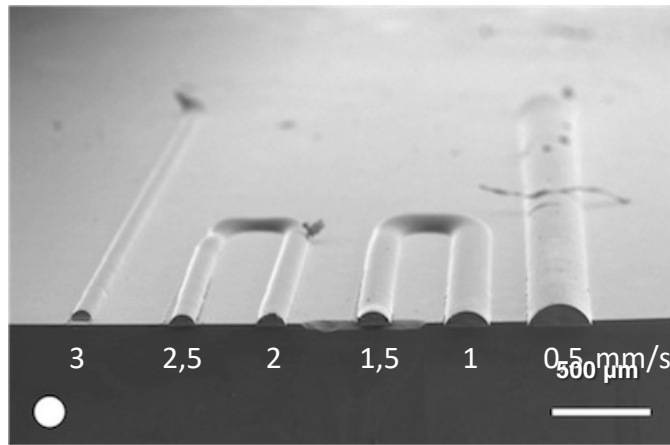
3D printing of liquid crystalline polymers

M. López-Valdeolivas et al., et al, Macromol. Rapid Commun. 39, 1700710 (2018)

C:P. Ambulo et al. ACS Appl. Mater. Interfaces 2017, 9, 37332

A. Kotikian et al, Adv. Mater. 2018, 1706164

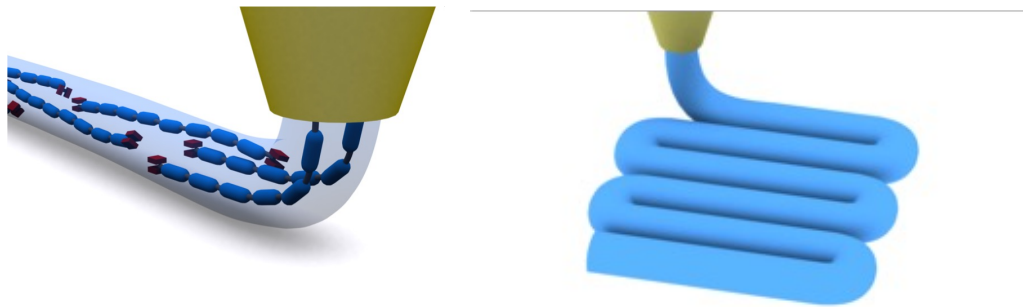
Printing speed vs printed fibre cross section area. Molecular alignment



Main chain orientation parallel to the needle movement direction.

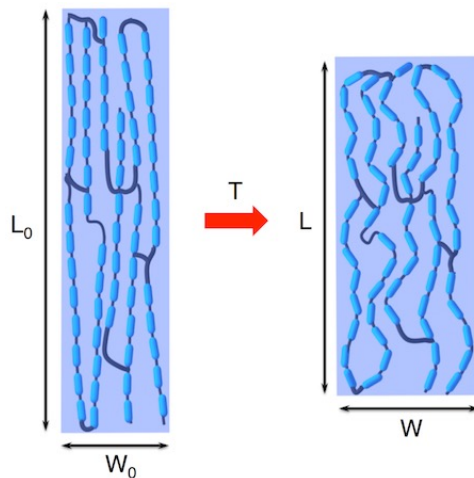
Digital control of the LCE morphology through 3D Printing

4D printing of liquid crystalline elastomers. Thermal actuation: Stress control

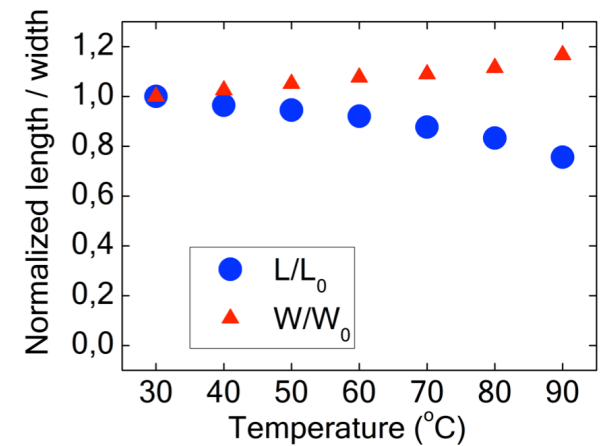
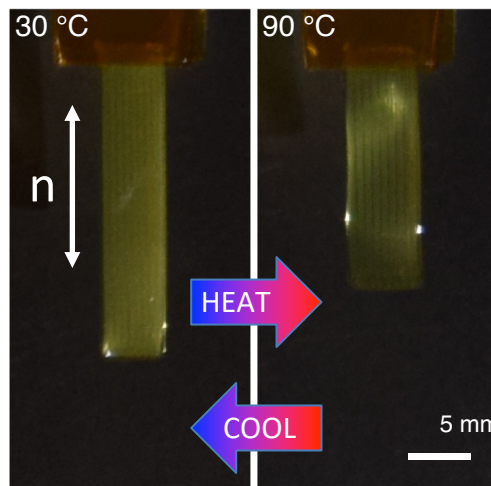


Thermal actuation lead to contraction along the printing direction

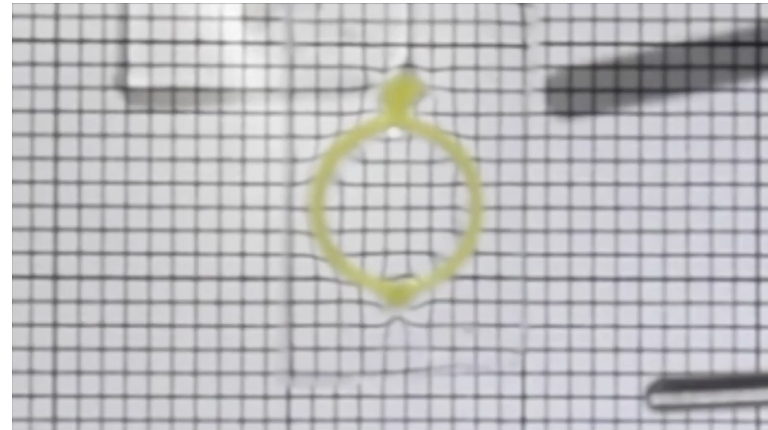
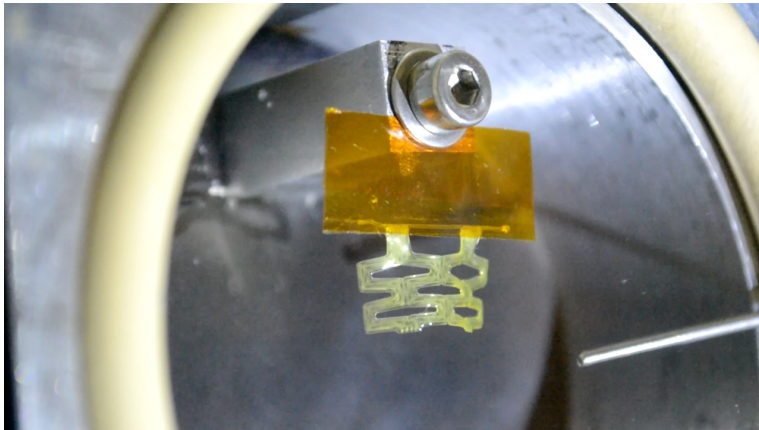
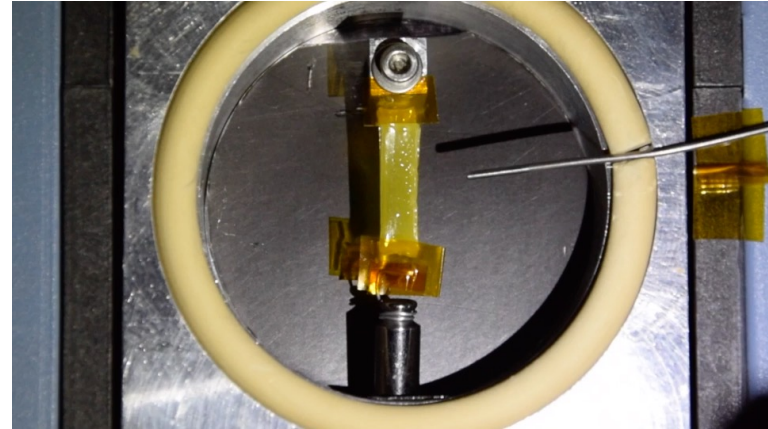
Thermal actuation



REVERSIBLE



Control over the material orientation during printing provides a control of the direction of the stresses within the stimulated material



M. López-Valdeolivas et al., et al, *Macromol. Rapid Commun.* 39, 1700710 (2018)

Digitally control director and therefore mechanical stresses in the material



López
Valdeolivas



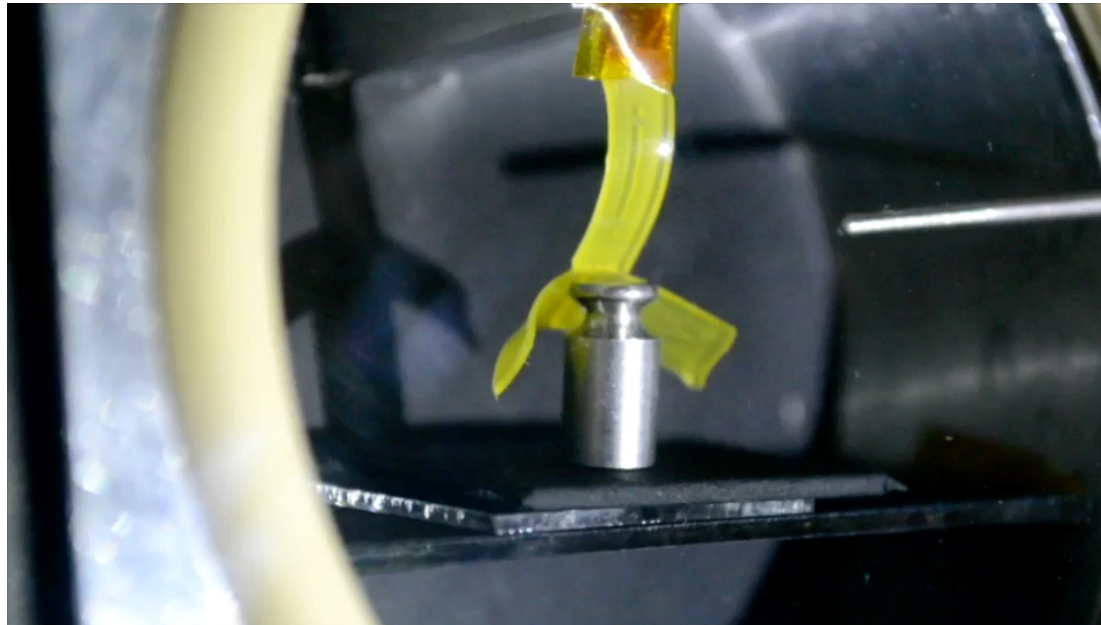
Hernández
Lombardini



Liu



Broer



Weight: 2 gr.
Robot weight: 0,09 gr.

Implementation of complex robotic functions

PRIME: A European collaborative project on the next generation of active microfluidic devices



FET-OPEN 2019-2023

<https://www.project-prime.eu>



This project has received Funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 829010

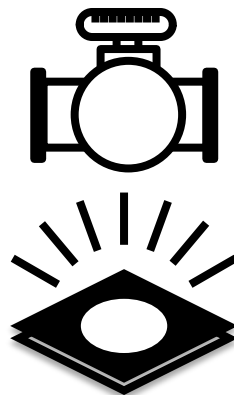
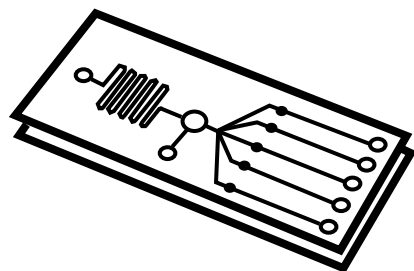
Advanced and versatile P^RInting platform for the next generation of active Microfluidic dEVICES



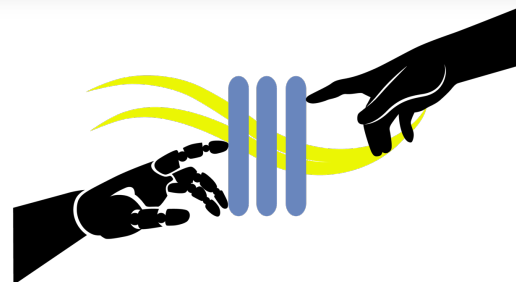
Coordinador



Grant Agreement Nr. 829010
Presupuesto total: 2.820.991 €
Presupuesto CSIC: 893.096 €
2019-2023
Coordinador



Desarrollo de una plataforma de fabricación de elastómeros cristal líquido que respondan a la luz para integrar todas las funciones fluidicas, válvulas y bombas en un chip microfluídico.



Grant Agreement Nr. 956150
Presupuesto total: 3.459.886,20 €
Presupuesto CSIC: 734.147,67 €
2021-2025
Coordinador

STORM-BOTS

Soft and Tangible Organic Responsive Materials progressing roBOTic functions

Training a new generation of young researchers in soft robotics



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 956150

9 Academic partners

9 Beneficiaries

9 Partner organizations

9 Non-academic partners

Coordinador CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

Universidad Zaragoza
1542

WAC-PLANG-GESellschaft

Sant'Anna
Scuola Universitaria Superiore Pisa

UNIVERSITY OF CAMBRIDGE

TU/e
EINDHOVEN UNIVERSITY OF TECHNOLOGY

Tampere University

Holst Centre
Eindhoven University of Technology

Universität Stuttgart



PRECEYES

سابك
salbic

aqdot

exact

VALUE IN DATA+
BY THE UNIVERSITY OF CAMBRIDGE

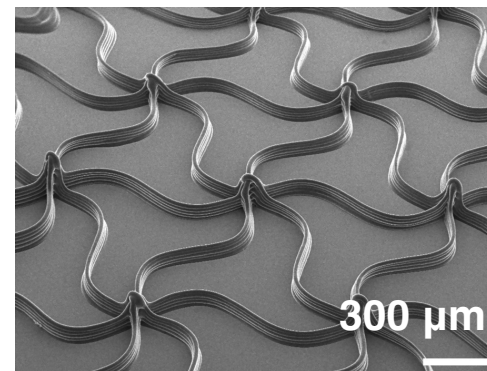
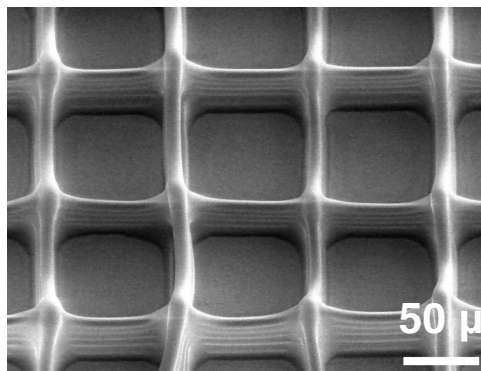
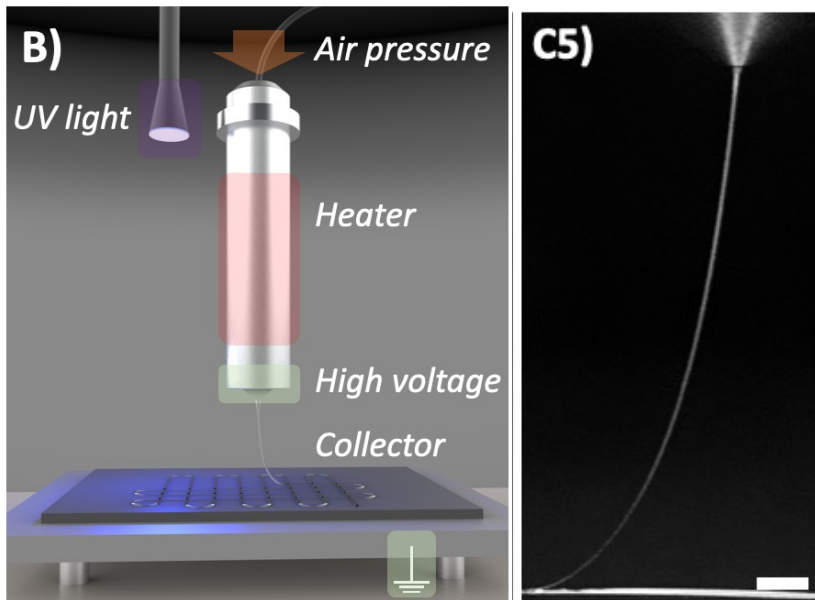
Lyncée tec

Vention

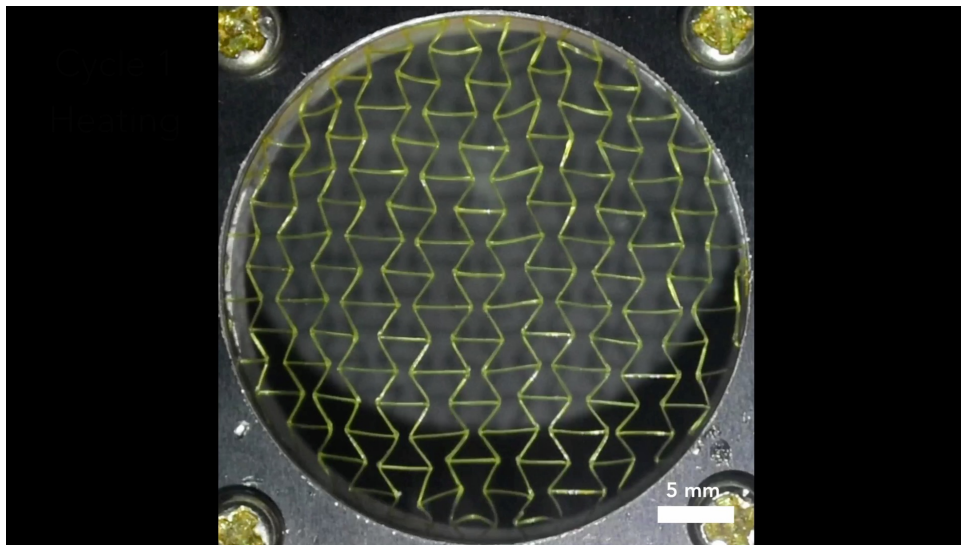
nB nanoScale Biomagnetics

BEOnChip
Biomimetic Environment On Chip

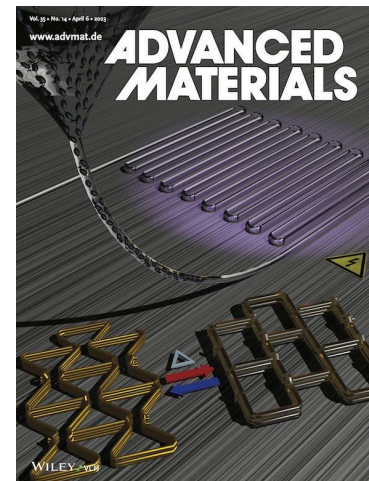




**Access to controlled morphology structures
with unprecedented dimensions**



Active scaffolds



Why does AML want to join BNN?. What do we expect?



Advanced Manufacturing Laboratory

- **BNN has been a reliable project partner...looking forward to future ones.**
- **BNN has a large network of members in areas of interest for AML. Looking forward to collaborate with you.**
- **AML wants to be a key partner in functional polymeric materials.**
- **AML wants to introduce smart materials and soft robotics in relevant applications. BNN is a great opportunity for this.**

ACKNOWLEDGEMENTS



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 829010



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Our network of collaborators and...
...you for your attention

5th BioNanoNet Member Welcome Webinar

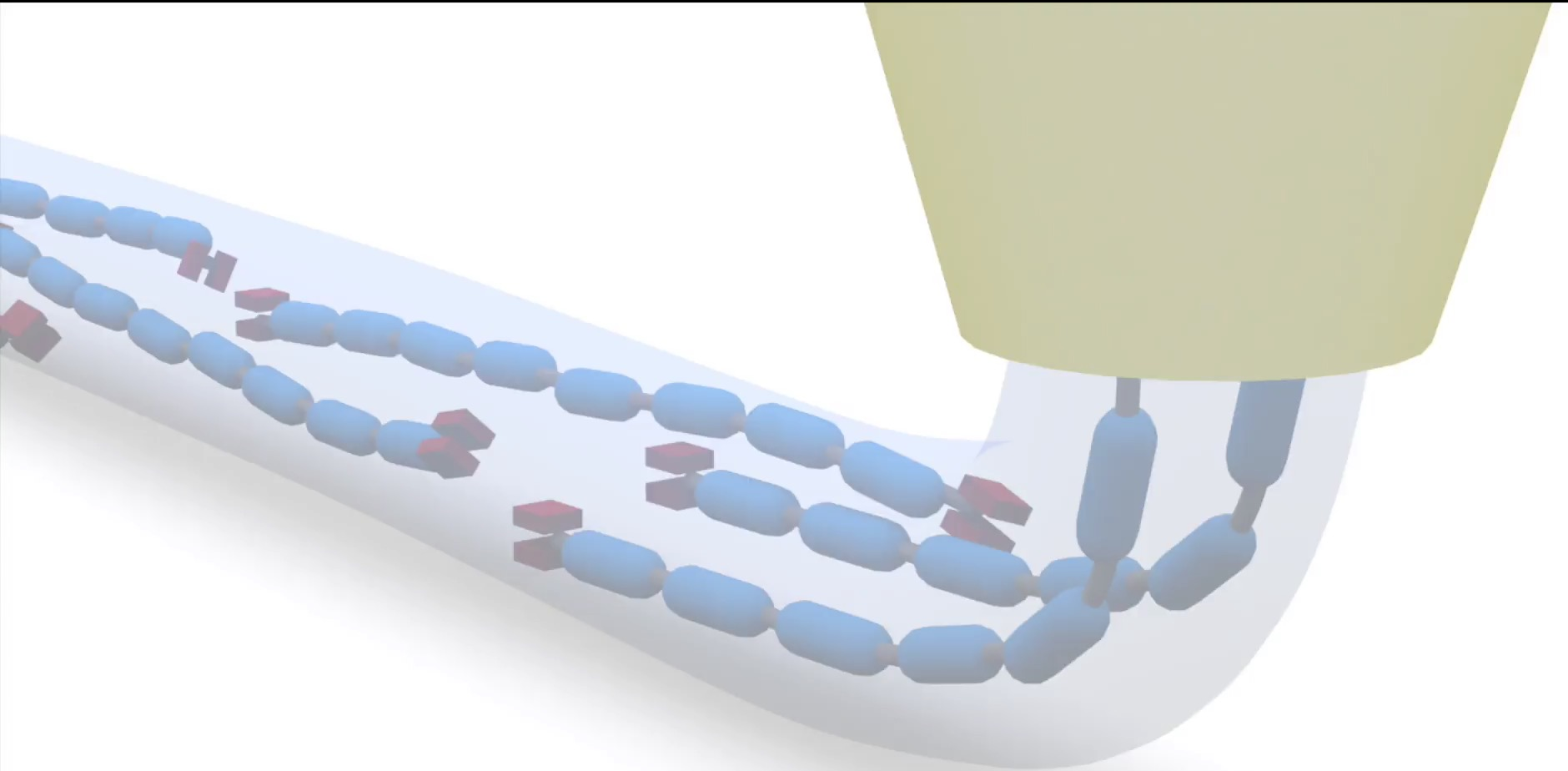
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4D Printed Actuators with Soft-Robotic Functions