Multifunctional and Composite Materials

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INSTITUTES

SCIENZE E TECNOLOGIE MOLECOLARI
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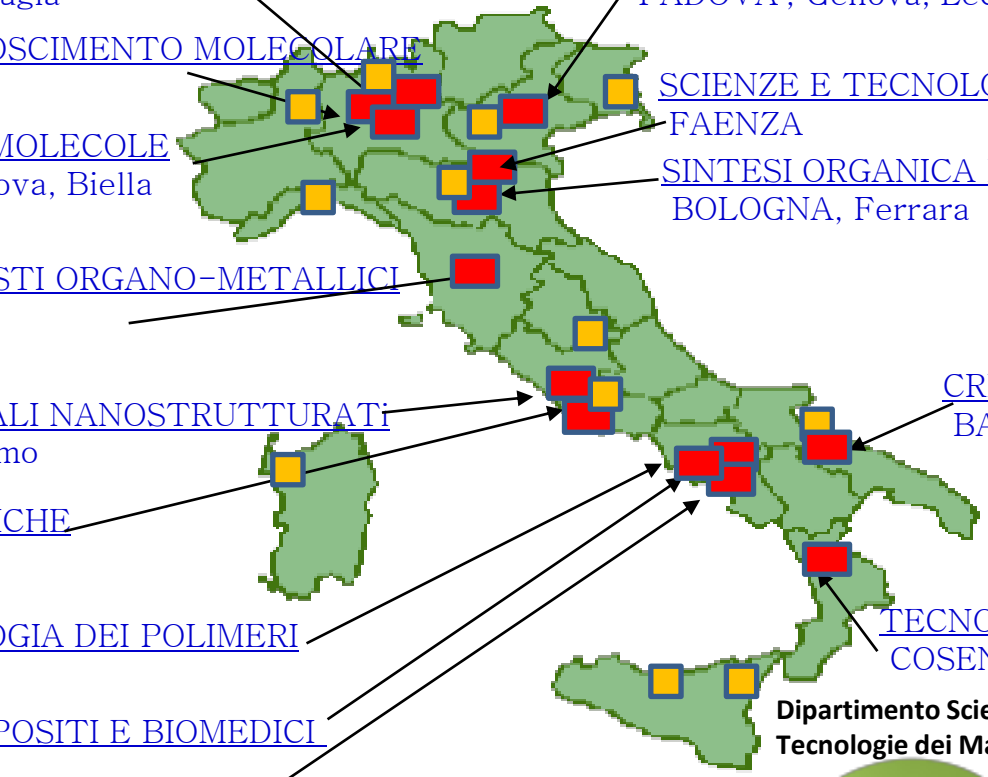
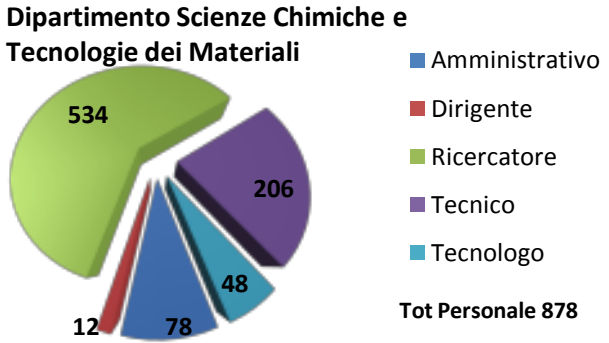
SCIENZE E TECNOLOGIE MATERIALI CERAMICI
FAENZA

SINTESI ORGANICA E LA FOTOREATTIVITA'
BOLOGNA, Ferrara

CRISTALLOGRAFIA
BARI , Roma, Trieste

TECNOLOGIA DELLE MEMBRANE
COSENZA, Padova





Department of
CHEMICAL SCIENCE and
MATERIALS TECHNOLOGY

RESEARCH PLATFORMS

SUISTANABLE CHEMISTRY

- Enzymatic reactions
- Hydrogen generation and storage
-Carbon Capture and Sequestration
-Energy from renewable sources
-Biorefinery
-Chemical processes with low environmental impact
- Modelling

ADVANCED MATERIALS KEY ENABLING TECNOLOGIES

- Nanostructures
- Polymers & Composites
- Ceramics & Composites
- Metals & Composites
- Biodegradable Materials
- Multifunctional Biomaterials
- Coatings & Adhesive
- Nanostructured Membranes
- Optoelectronic& Photonics
- Sensors
- Rapid Prototyping

NANOMEDICINE

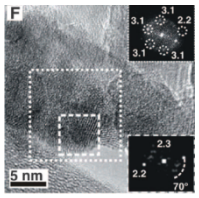
- Tissue Engineering
- Natural biopharmaceutical molecules
- Drug delivery
- Drug discovery
- Nanoparticles
- Biosensors
- Nutraceutics
- Teradiagnostic
- Modelling

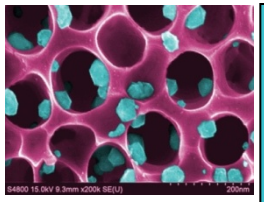
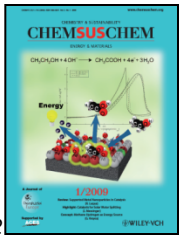
Health | **Energy** | **Transports** | **Cultural Heritage** | **Made in Italy** | **Building** | **Industrial Processes** | **Advanced Manufacturing**

SUSTAINABLE CHEMISTRY

Main Activities - Results

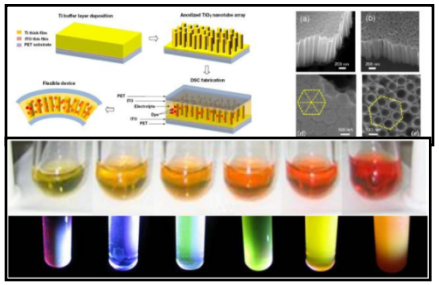
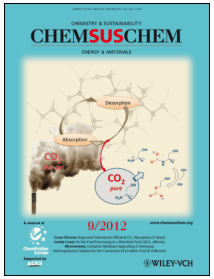
- *New sustainable chemical processes with high efficiency and selectivity.*
- *Electro/photocatalysis for applications in the energy sector*
- *Hydrogen chemistry and technology: production, storage and employment in fuel cells.*

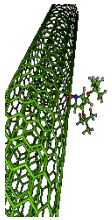


Science 2012 *CNR patents, 2006 - 2012*

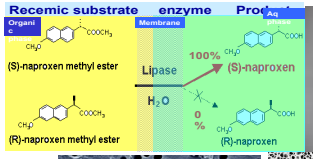
- *Organic and organometallic compounds for third generation photovoltaics*
- *Technologies for C1-chemistry: CO_2 exploitation and confinement (CCS)*
- *Organic, inorganic and hybrid polymeric materials with functional properties*

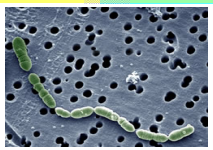
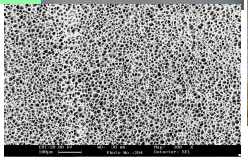


CNR patent, 2011

- *Functional nanostructure membranes*
- *Protein based thermoplastic products*
- *Packaging*



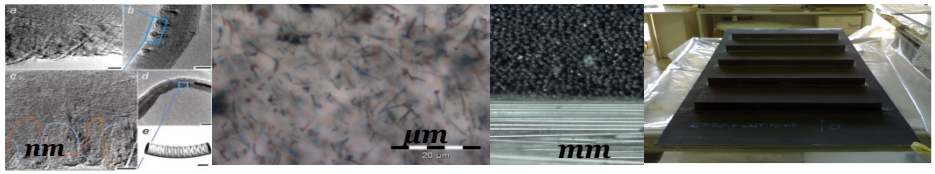


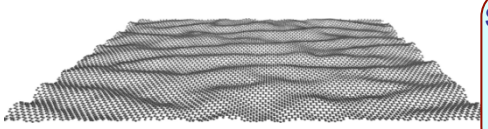
ADVANCED MATERIALS & ENABLING TECHNOLGY

Main Activities - Results

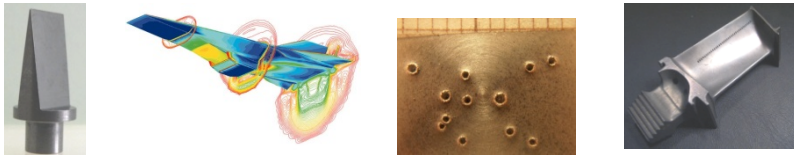
- *Multi scale polymer nano-composite*



- *Graphene based materials*

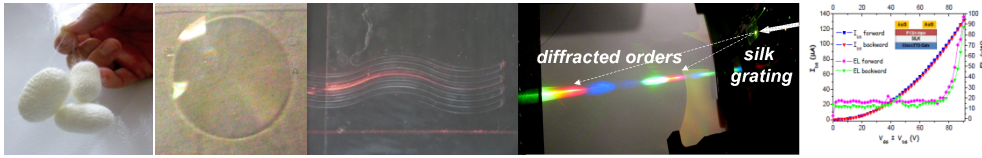


- *Ceramics and metals for extreme conditions*



- *Materials technology for cultural heritage*

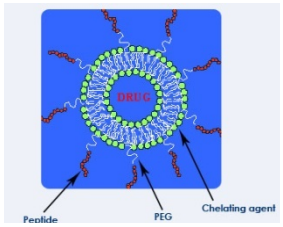
- *Silk fibroin in optoelectronics devices: Transistors & light emitting transistors*

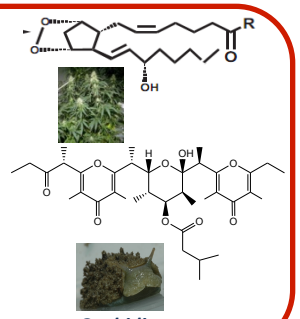


NANOMEDICINE

Main Activities - Results

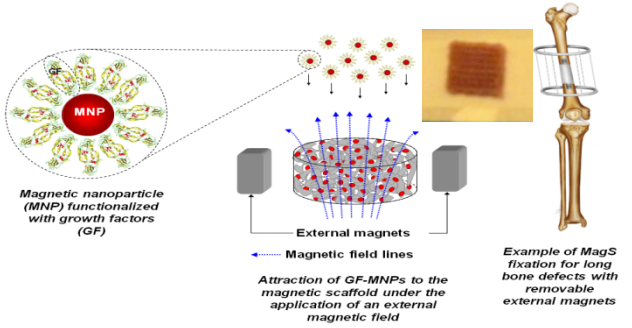
- *Development of new drugs and diagnostics on molecular basis.*
- *Protein expression, Structural and Computational Biology, Cellular Biology, HTS technologies.*
- *Isolation and characterization of new molecules from natural substances for health, cosmetics and pharmaceuticals.*



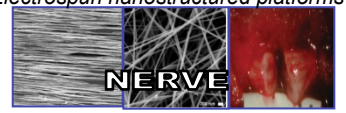


Onchidium sp.

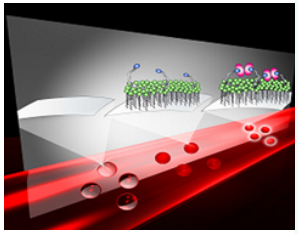
- *Magnetic nano-composite scaffolds*
- *Electrospun nanostructured platforms.*
- *Hydrogels for Protein release for central nervous pathology*

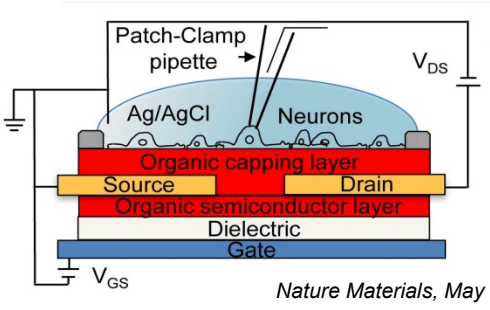


Electrospun nanostructured platforms

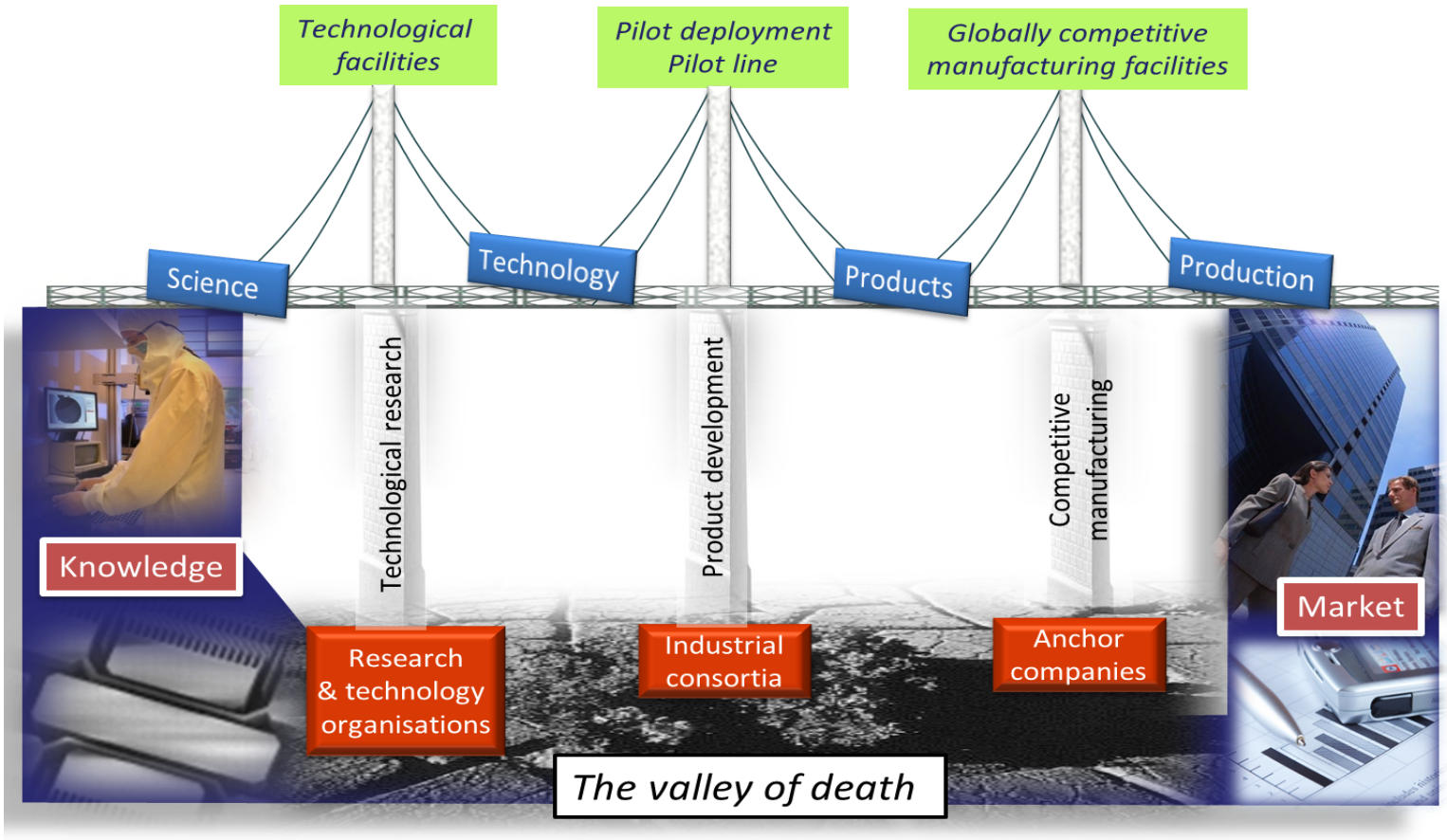


- *Biosensors*
- *Bio-electronics platforms* - Transparent Organic Cell Stimulating and Sensing Transistors *for neural cells*





Nature Materials, May 2013



The technological research pillar based on technological facilities supported by research technology organisation;

The product development pillar based on pilot lines and demonstrator supported by industrial consortia

The competitive manufacturing pillar based on globally competitive manufacturing facilities supported by anchor companies.

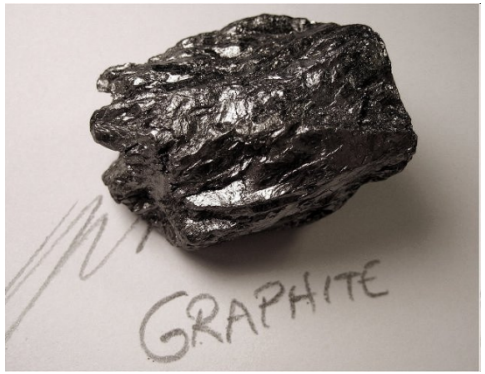
Whilst European R&D is generally strong in new KET technologies, the HLG has observed that the transition from ideas arising from basic research to competitive KETs production is the weakest link in European KET enabled value chains.

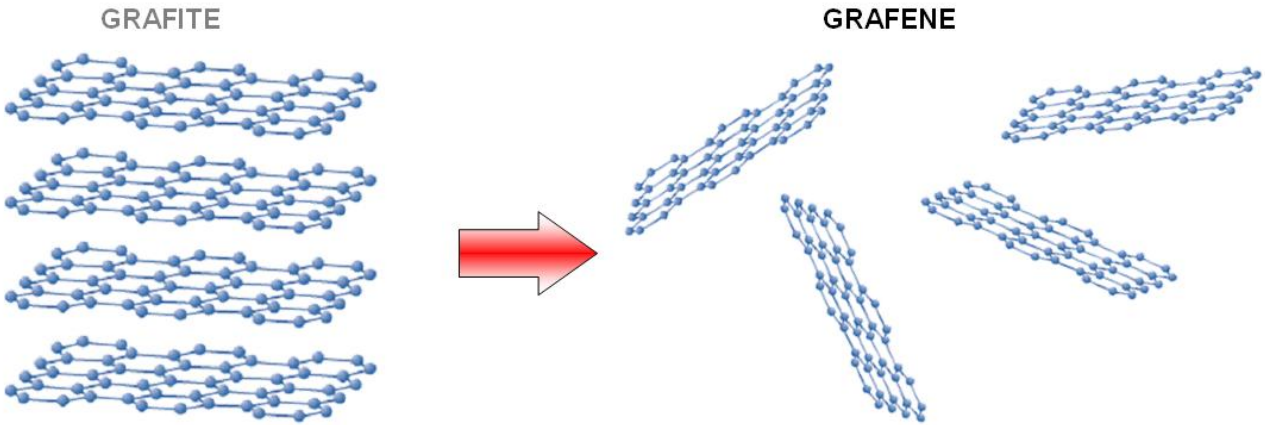
The gap between basic knowledge generation and the subsequent commercialization of this knowledge in marketable products, has been commonly identified across the KETs and is known in broad terms as the "valley of death" issue.

This “Valley of Death” has been identified in many competitor countries, including the USA, China and Taiwan. All have established coordinated programmes in strategically important areas that cover the full innovation chain addressing basic and applied research, demonstrators, standardization measures, deployment and market access, all at the same time and, significantly, in a logical joined-up manner.

The CNR Research Area in Bologna

Technopole AMBIMAT INFRASTRUCTURES
CNR – Regione Emilia-Romagna





- **High Mechanical strength**
- **High surface area (upper limit 2600 m^2/gram)**
- **High transparency**
- **Unique optoelectronic properties (saturable absoprtion, ballistic electron transport, linear energy-momentum dispersion, etc.)**
- **... and many others!**

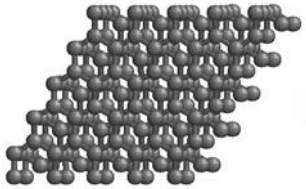
Surface area:	
Theoretical maximum 2600 m^2/g	
Typical	**100-1000 m^2/g**

Charge mobility ($cm^2V^{-1}s^{-1}$):	
Silicon	**1400**
Graphene	**15000**

Young modulus (GPa):	
Steel	**200**
Graphene	**1000**

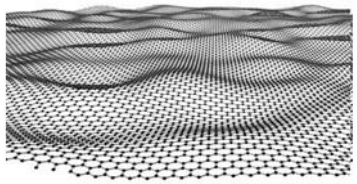
Thermal conductivity ($Wm^{-1}K^{-1}$):	
Copper	**401**
Silver	**429**
Graphene	**5000**

GRAPHITE



GRAPHENE

(NEWEST AND MOST STUDIED CARBON-BASED MATERIAL)



APPLICATIONS

TRANSPARENT CONDUCTING DISPLAYS (ITO replacement)

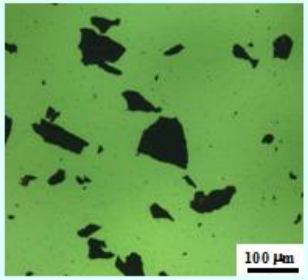
ELECTRON ACCEPTOR (excellent charge mobility, very high surface area)

COATINGS (inert, high barrier to oxygen and moisture)

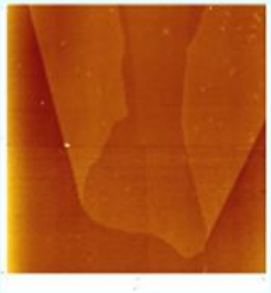
Nanochemistry Lab

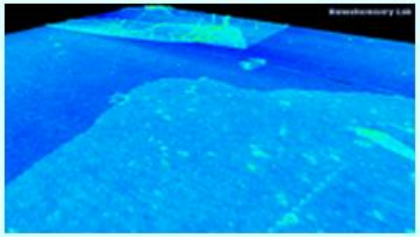
GRAPHENE PRODUCTION AND RESEARCH @CNR Bologna

SOLUTIONS
in water and solvents, gram scale

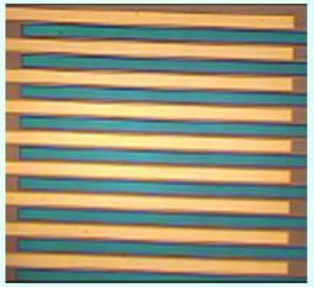


MONOATOMIC SHEETS
Size form 1 to 100 µm





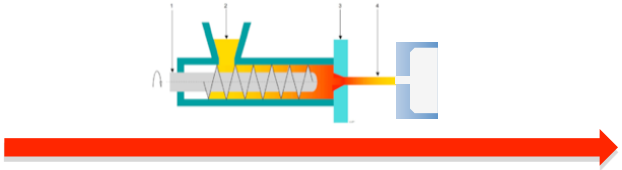
COATINGS
on silicon, glass, quarz, metals…



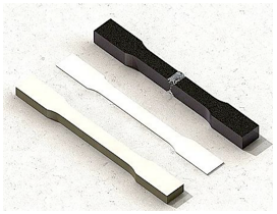
From Molecules to Materials……. to Market

PELLETS

EXTRUSION



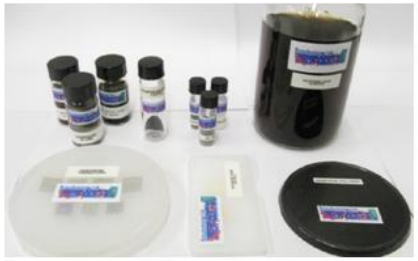
NANO-COMPOSITES

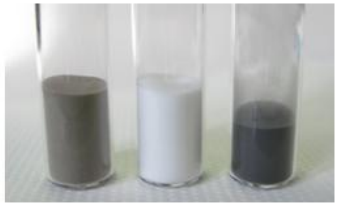


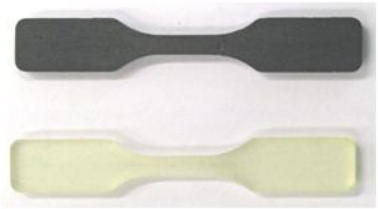
DISTRETTI 2

dai distretti produttivi
ai distretti tecnologici - 2

Graphene is a multifunctional reinforcement that can improve electrical, thermal, mechanical, and gas barrier properties of polymers at extremely small loading.







NETWORKING ACTIVITY ON GRAPHENE @ISOF

GOSPEL GENIUS

Project leader: ISOF CNR, Bologna, Italy.

- Cambridge University, United Kingdom
- Manchester University, United Kingdom
- BASF, Germany
- Max-Planck Institute, Germany
- University of Strasbourg, France
- University College, London, United Kingdom
- Berlin Free University, Germany
- Swiss Federal Laboratories for Materials Testing & Research, Switzerland
- University of Nova Gorica, Slovenia
- University of Mons-Hainaut, Belgium
- Humboldt University, Germany

GRAPHENE FLAGSHIP

MIST E-R

Contacts:
vincenzo.palermo@isof.cnr.it
www.isof.cnr.it
www.laboratoriomister.it
www.graphene-flagship.eu/GF/index.php

Building up "greentronics"

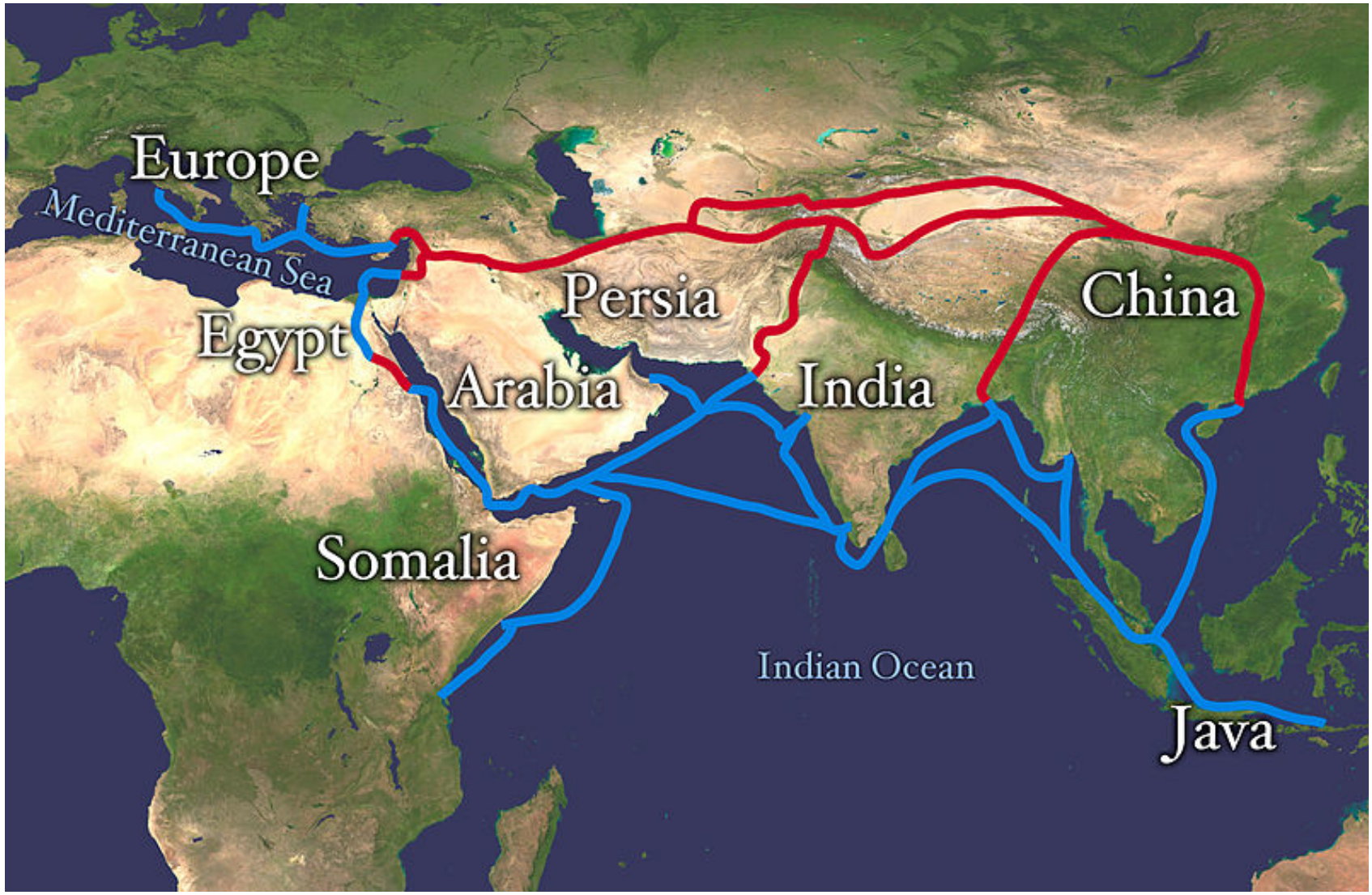
an across-the-sea initiative

Ecosustainable bio-based optoelectronic devices

Biomanufacturing

Converging sciences & technologies

The Silk route



The silk producer

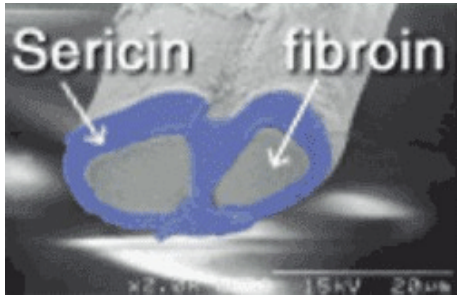
Bombix-Mori

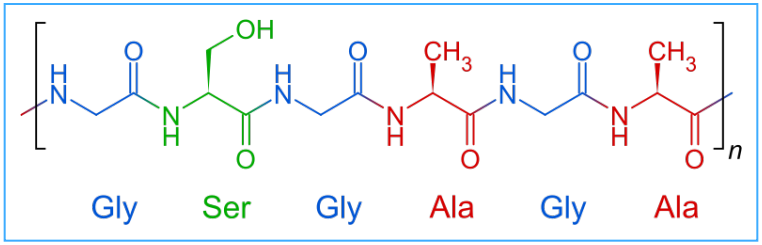
by Mattia Leonardi, 9 years old, the silk-generation Award 2012 italian young scientific journalist

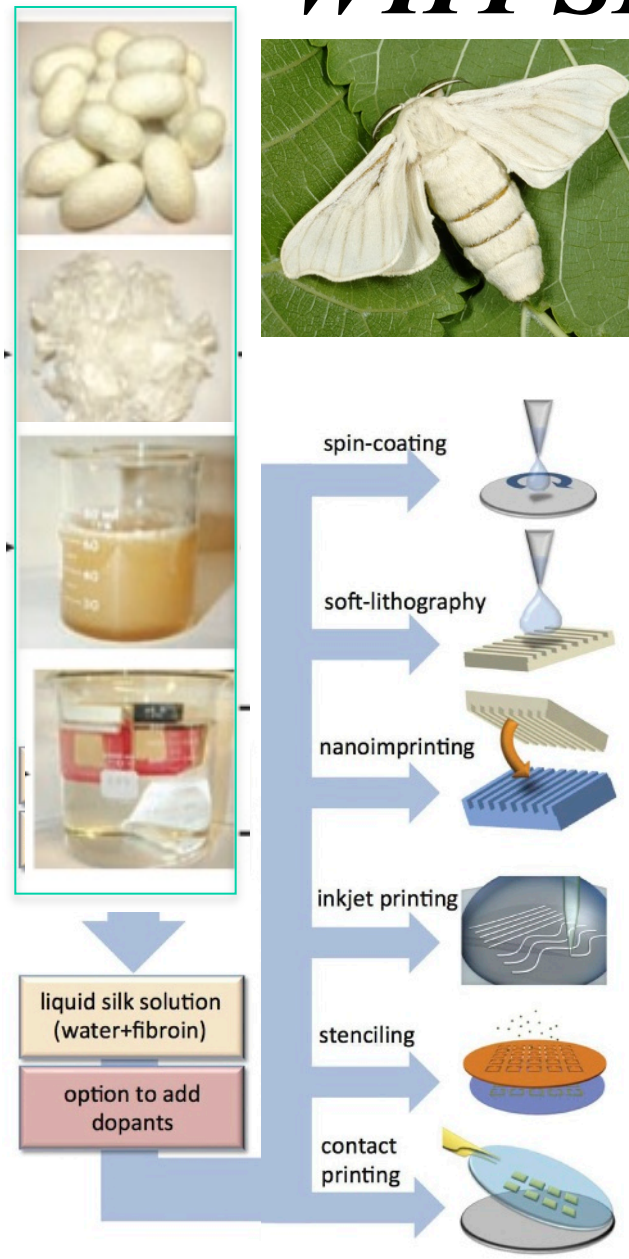
Building up a SILK-Technological platform

an across-the-sea initiative *Silk Optics*

WHY SILK FIBROIN

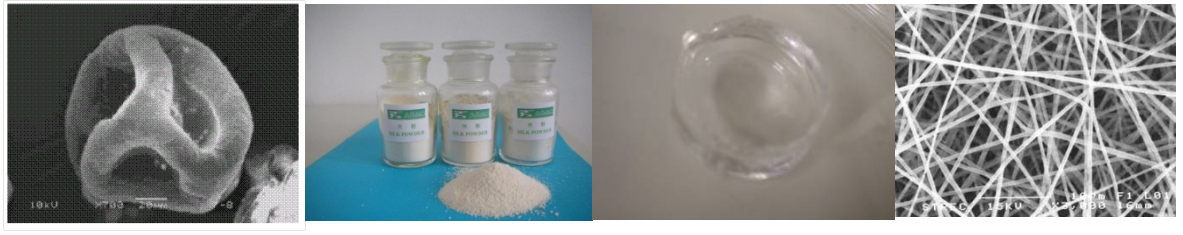






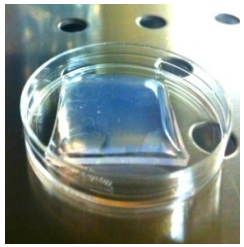
- **Solvent free process**

- **Solution processable substrates**

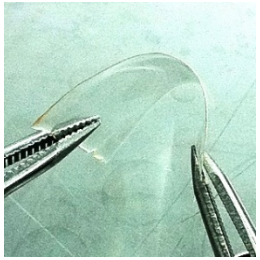


Silk fibroin films for optoelectronic

Solution processable

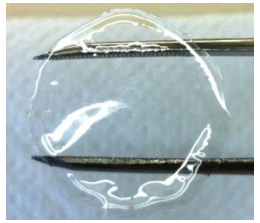


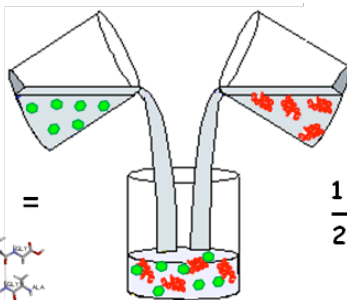
Self assembly in thin film



Ecosustainable process
Low enviromental impact

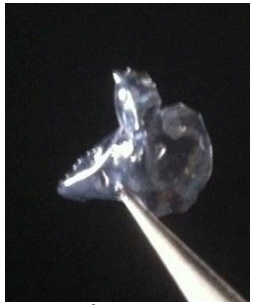
Flexible transparent



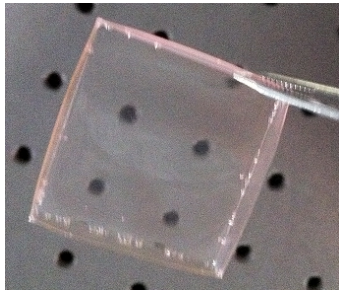


Possibilities of functionalization

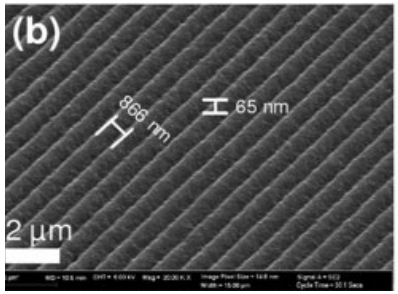
Controlled Biodegradation and dissolution



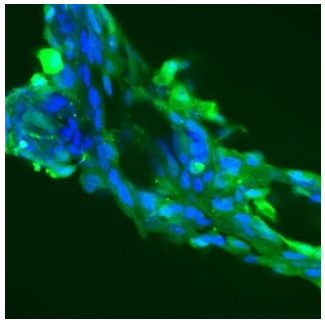
Novel Materials



Nano e micro structure

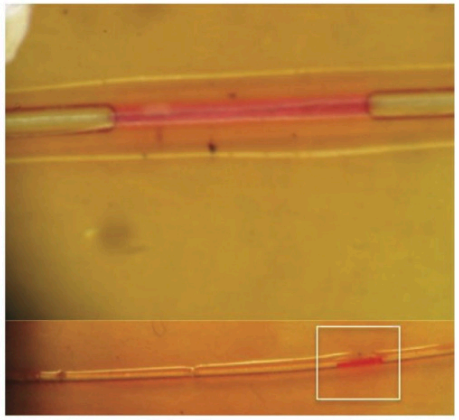


Biocompatible

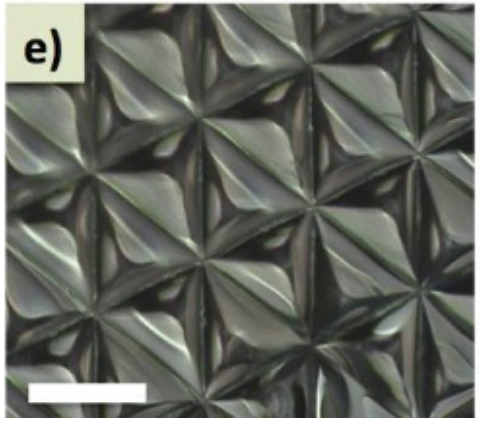


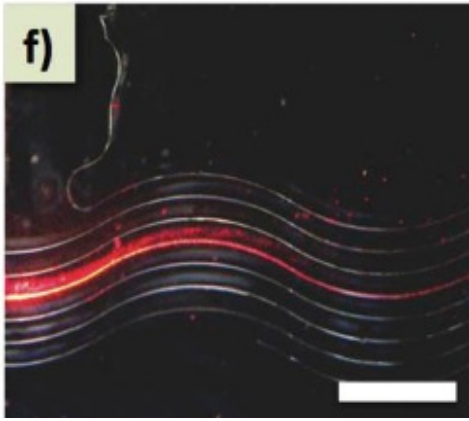
Silk fibroin: tecnological applications

Microfluidics Biosensors

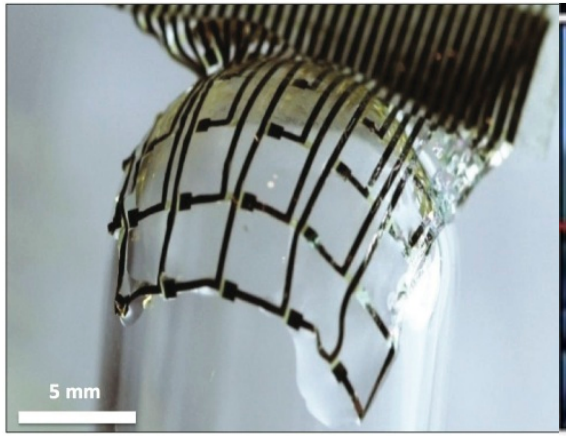


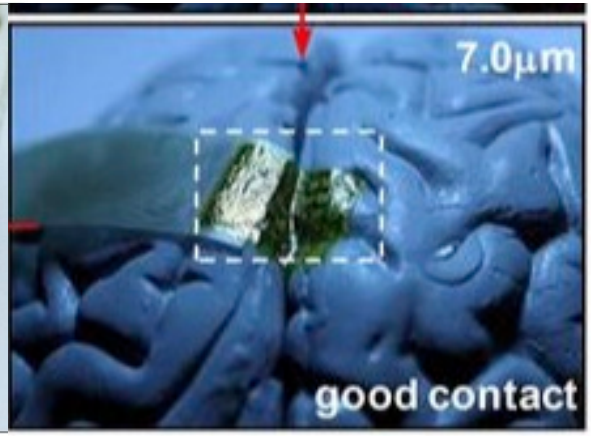
Photonics structure and optical waveguiding

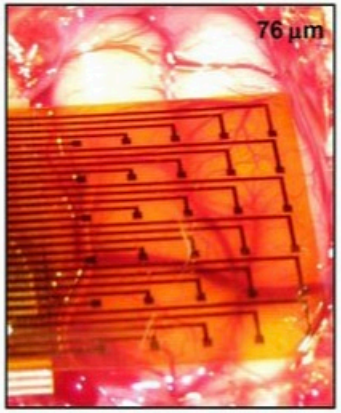


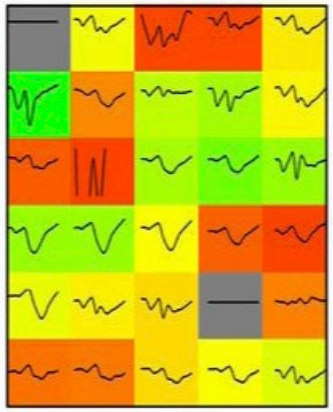


Flexible support of Implantable biomedical device in vivo

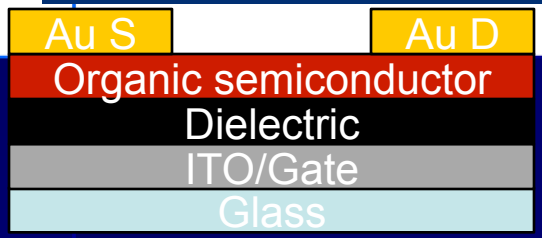






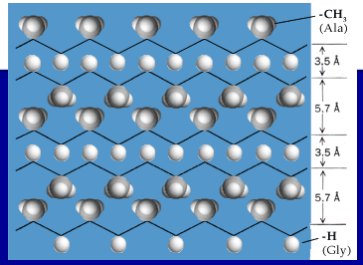


A) Integration of BIOPOLYMER in Optoelectronics



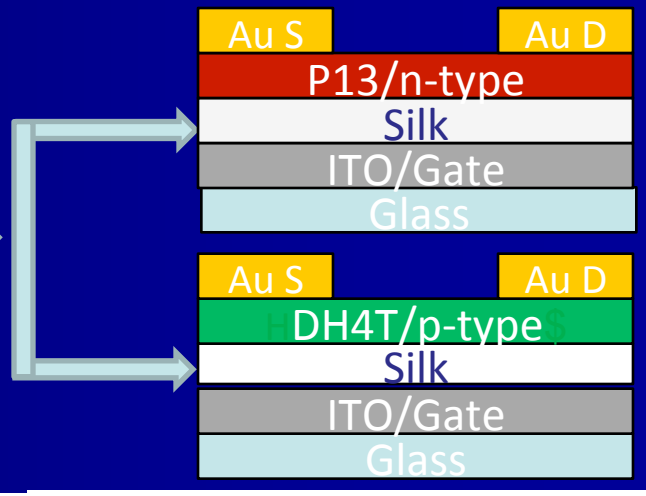
SiO_2

PMMA

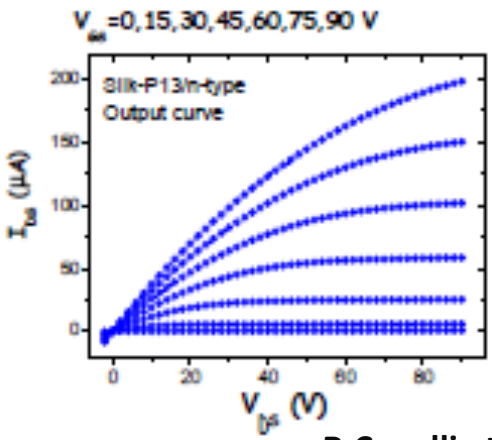


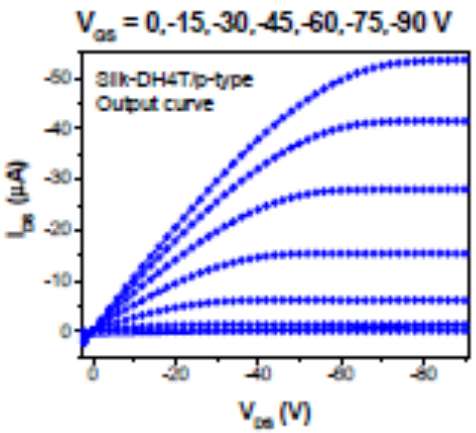
B) Silk-Fibroin extraction and processing

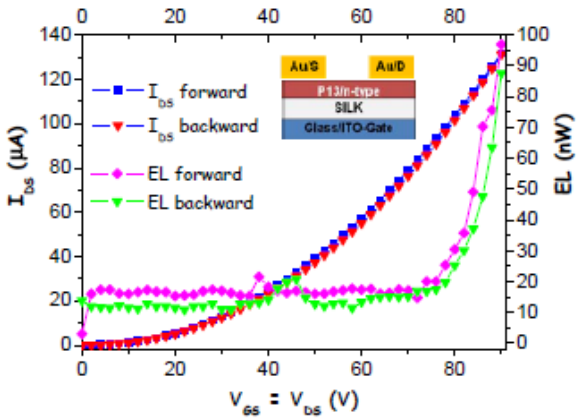
Silk-based devices fabrication



C) Silk-based devices performance

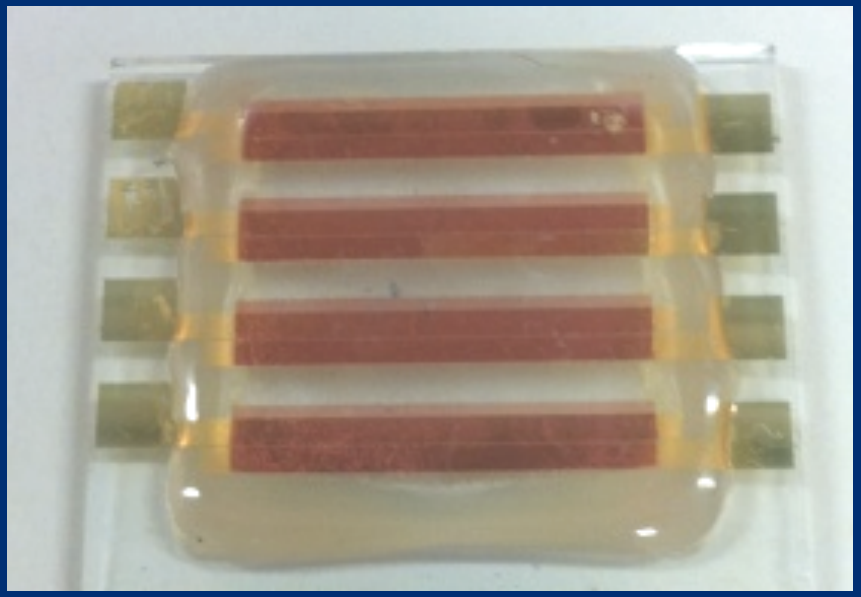


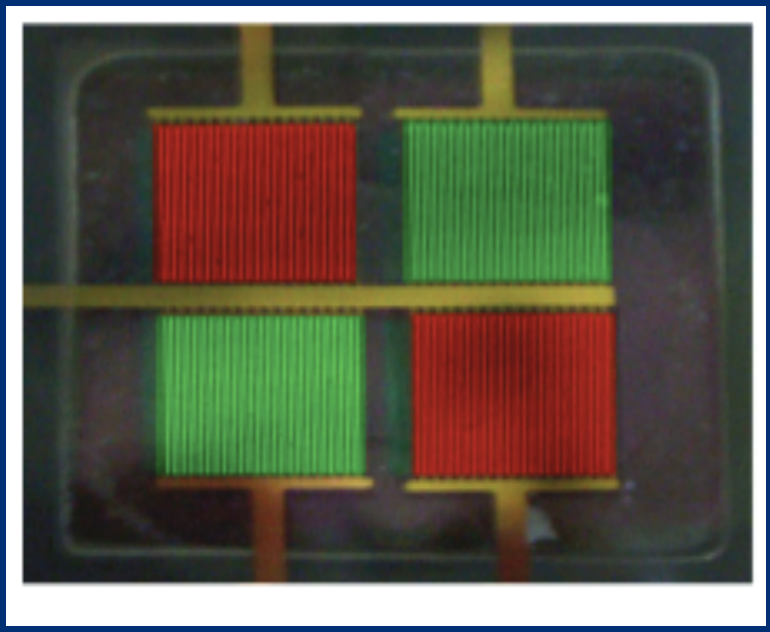




R.Capelli et al. Organic Electronics (2011)

Silk-based OLET ,OLED devices





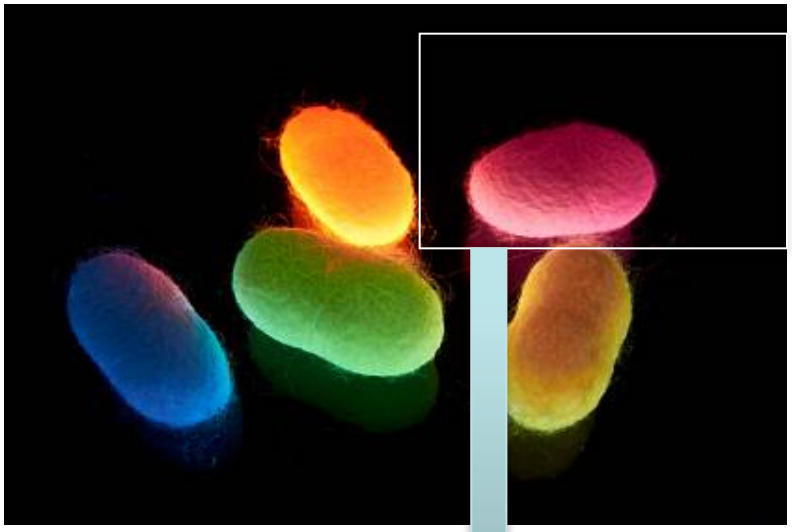
Biomanufacturing of high tech material

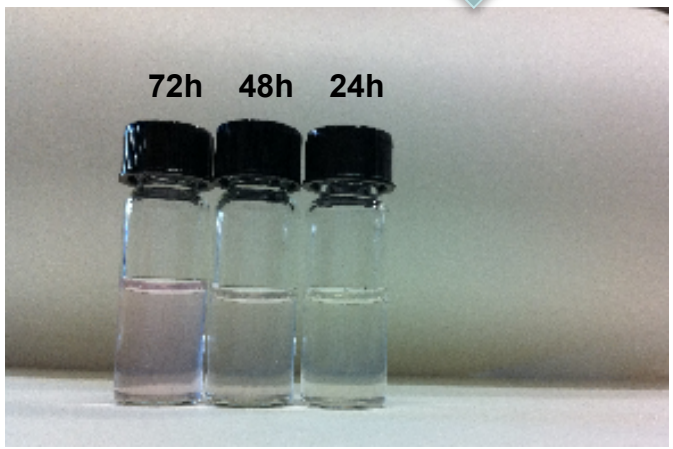
Consiglio Nazionale delle Ricerche
Istituto di Biometeorologia -

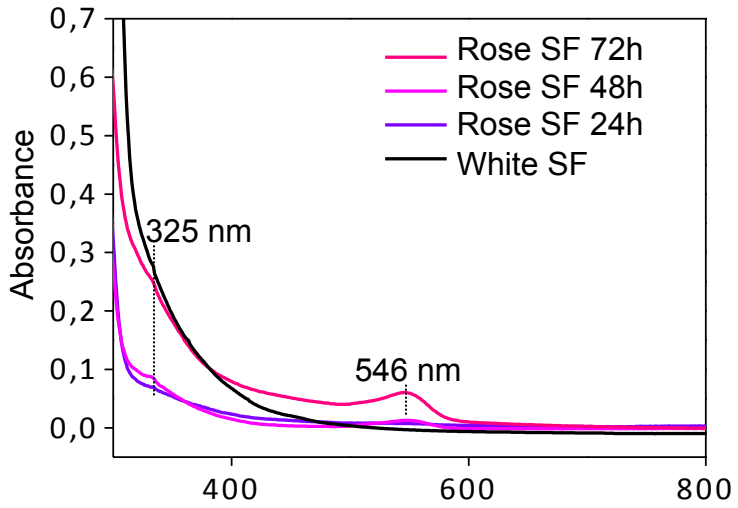
Standard diet

Modified diet

Diet modified silk fibroin

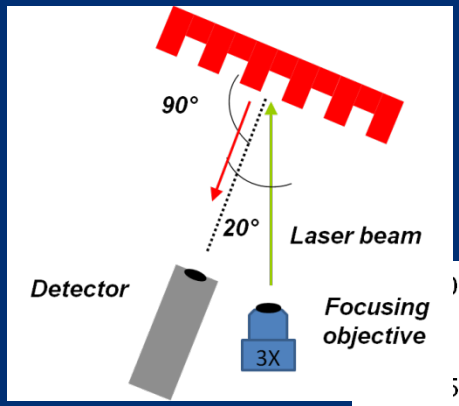


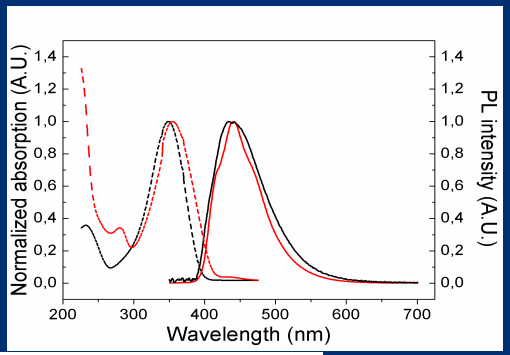


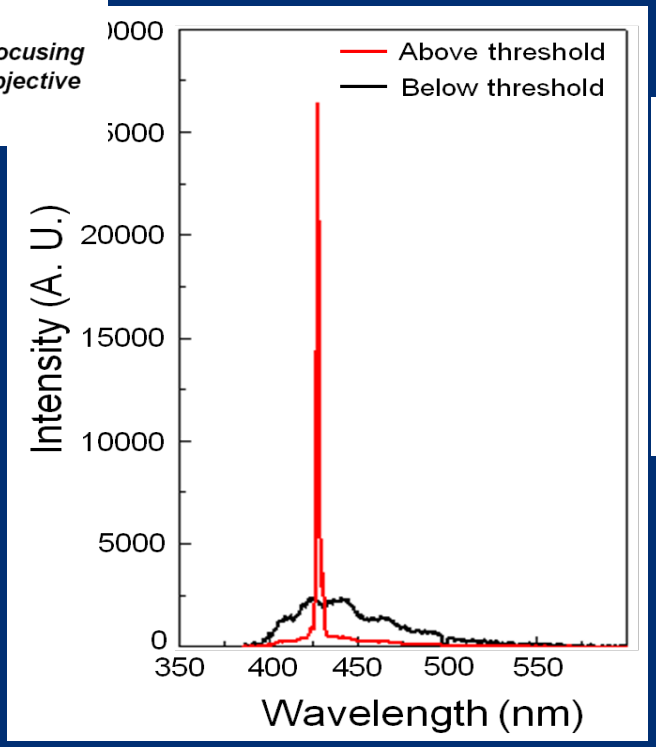


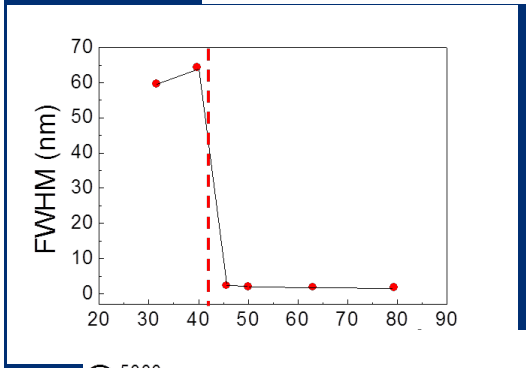
Building up a SILK-Technological platform

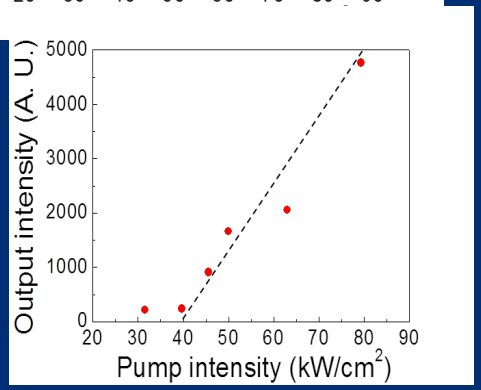
Silk LASER







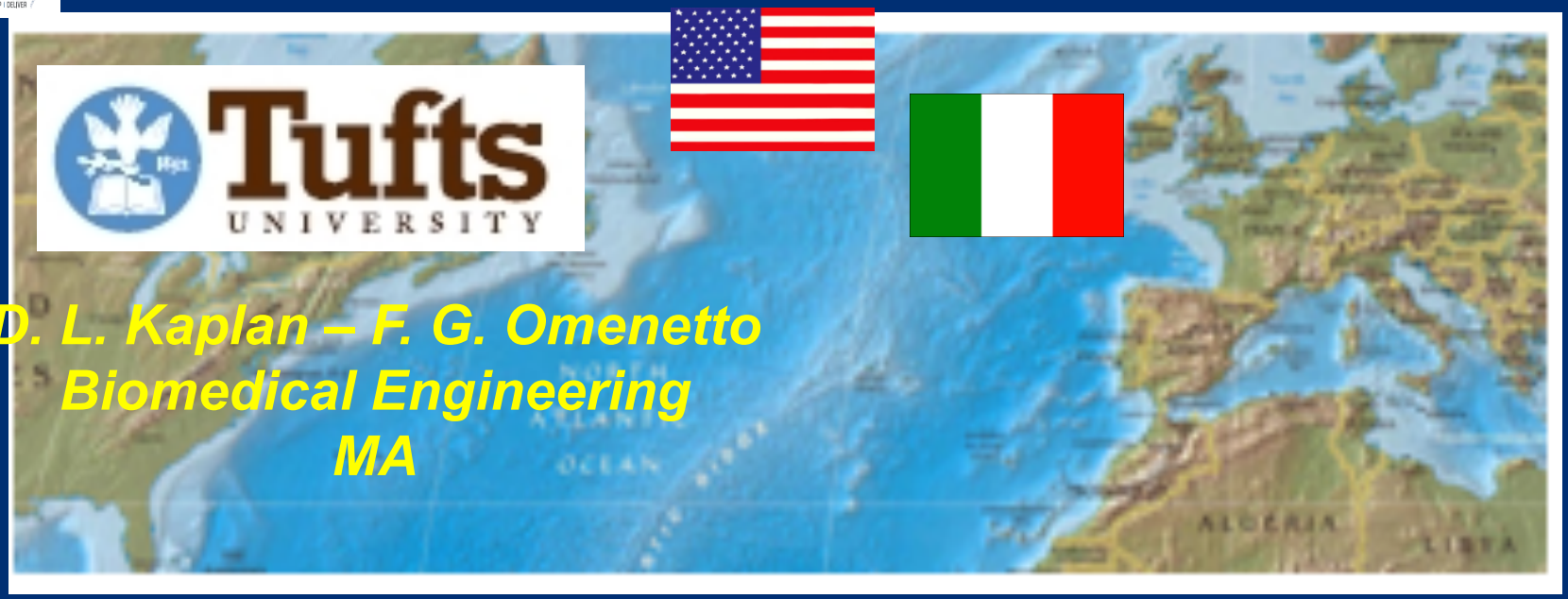




S.Toffanin et al. APL, 2013

Building up a SILK-Technological platform
an across-the-sea initiative

James G. Grote
Materials and Manufacturing Directorate
Ohio
Andrew Steckl
Cincinnaty Univ



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Building up “green-Biotronics”

an across-the-sea initiative

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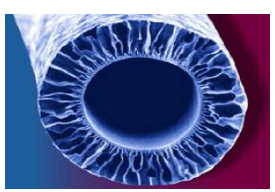
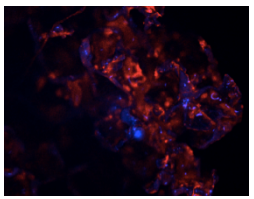
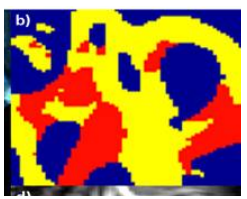
Steen Rasmussen


THANK YOU!




b)