# Activity of the Silk Division of Innovhub

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# Outline

1. Presentation of Innovhub - SSI

2. Research Priorities of Textile and Silk Sectors

3. Research Projects of the Silk Division

a. Textile Projects

b. Biomedical Projects

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# From Stazione Sperimentale per la Seta to Innovhub-SSI

## Until Sept. 2011: Stazione Sperimentale per la Seta (SSS)

- ✓ Independent Public Research Institute supervised by the Ministry of Industrial Development
- ✓ Board of Directores: representatives of Industrial Associations, Ministry
- ✓ Funding: public contribution, research projects, testing and consultation activity

STAZIONE SPERIMENTALE
PER LA SETA

## From Oct. 2011: Innovhub – Stazioni Sperimentali per l'Industria

- ✓ Special Agency of the Chamber of Commerce of Milan resulting from merging 4 Stazioni Sperimentali relating to different industrial sectors plus 1 Innovation Agency

INNOVHUB
Innovazione per le PMI

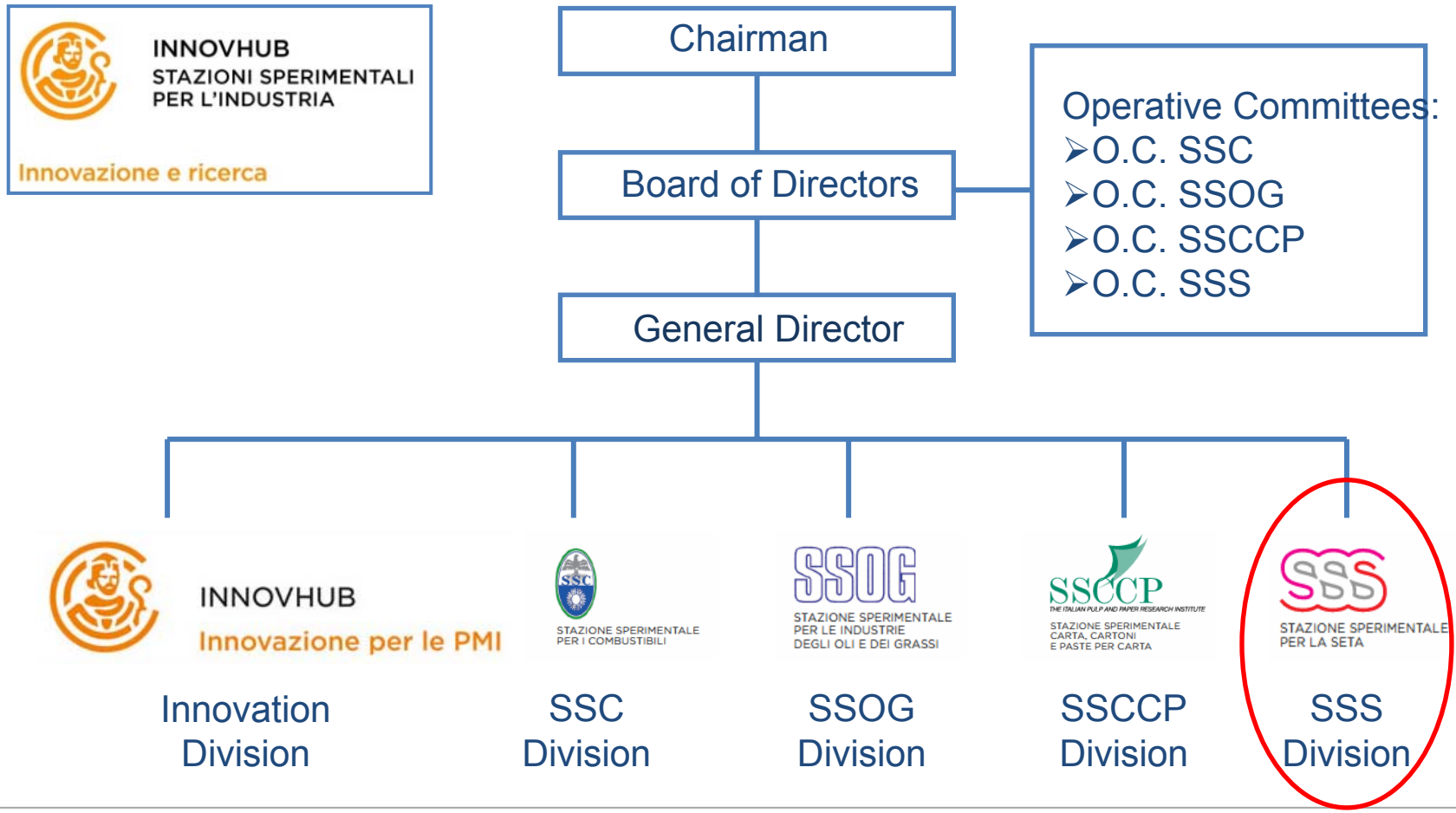
STAZIONE SPERIMENTALE
PER I COMBUSTIBILI

SSOG
STAZIONE SPERIMENTALE
PER LE INDUSTRIE
DEGLI OLI E DEI GRASSI

SSCCP
THE ITALIAN PULP AND PAPER RESEARCH INSTITUTE
STAZIONE SPERIMENTALE
CARTA, CARTONI
E PASTE PER CARTA

STAZIONE SPERIMENTALE
PER LA SETA

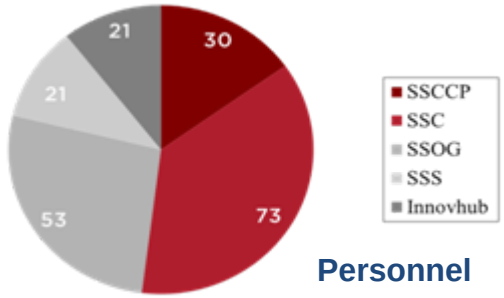
# Organization of Innovhub – SSI



# Mission and Activity of Innovhub – SSI

**Mission:**
To improve competitivity of the Italian industrial system by **promoting scientific and technological innovation** and providing support services and assistance to companies interested in developing R&D projects

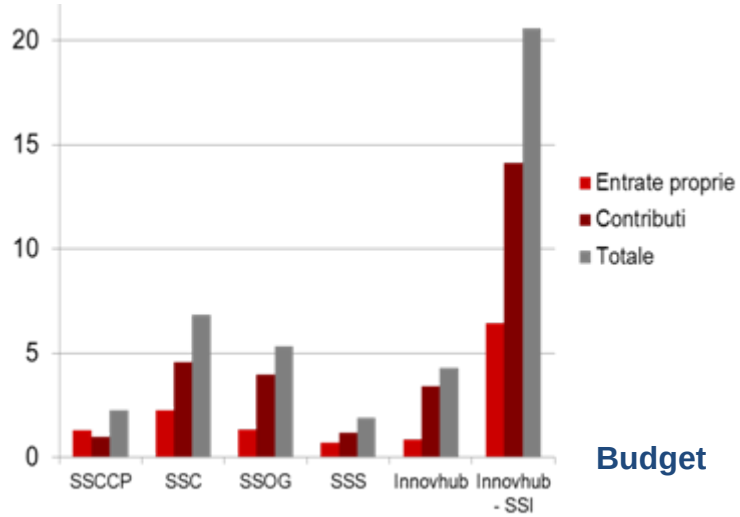
**Resources and facilities:**
- Human resources: about **200 employees**, most of which researchers
- Facilities: **research laboratories** equipped with advanced analytical tools and pilot plants




**Personnel**

**Activity:**
- **Industrial research**, pre-competitive developments, technology transfer
- Testing and process/product certification
- Training, dissemination, business support services
- Technical standardization

**Funding system:**
- Public contribution, research projects, testing and consultation activity, ...




**Budget**

# Web site of Innovhub – SSI

## *http://www.innovhub-ssi.it/*

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Innovazione e ricerca

BACSA

STAZIONE SPERIMENTALE
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# The Silk Division of Innovhub – SSI

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## Industrial sectors:

- Fuels (oil, gas, biofuels, …)
- Cosmetics, detergency, paints, lubricants, ...
- Pulp and paper
- Textiles

## Analytical laboratories:

- Physical-mechanical tests
- Spectroscopic analysis (FTIR, XRD, ICP, ...)
- Chromatographic analysis (HPLC, GC-MS, ...)
- Morphological analysis (SEM, OM, ...)
- Thermal analysis (DSC, TGA, ...)
- ...

**Pilot plants**

**ACCREDIA Certified Labs**

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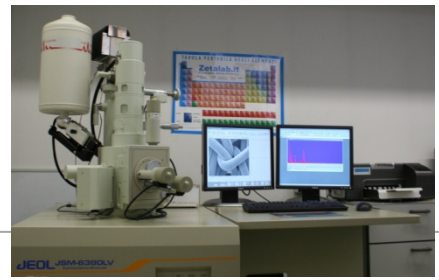
## Research and testing activity:

- Starting materials
- Intermediates
- Final products
- Process development and optimization
- Environmental impact of processes

## Laboratories:

- Physico-mechanical, technological
- Microscopy (SEM, OM), Spectroscopy (FTIR, UV/Vis/NIR, Fluorescence, ICP), Thermal analysis (DSC, TGA), Chromatography (HPLC, GC-MS)



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# Innovation and Competitivity of the Textile Sector

**Innovation** + **Sustainability** = **Competitivity**

- ✓**environmental**
- ✓**economical**
- ✓**social**

Which kind of innovation do we need?

**Incremental** innovation

- is a **step forward** along a technology trajectory
- is made by those working day to day with **existing methods and technology**
- generally consists in **minor improvements** of existing products, processes and services
- responds to **short term** goals
- is **easily reachable** by competitors

**Breakthrough** or **radical** innovation

- involves **considerable change** in basic technologies and methods
- is created by those working outside mainstream industry and **outside existing paradigms**
- involves launching an **entirely novel** product or service
- it is **risky** but, if successful, the rewards can be tremendous
- involves larger leaps of understanding, perhaps demanding a **new way of seeing** the whole problem

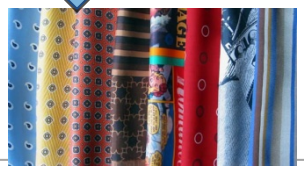
# Silk Research: Needs and Priorities

Cocoon production
Reeling (raw silk)
...
...
Twisting
Weaving
Knitting
...
...
Preparation
Dyeing
Printing
Finishing
...

*Raw materials production and supply*

*Manufacture of textile structures*

*Styling, finishing, functionalization*



## R&D priorities

- Strategic issue for the EU silk industry
- R&D should involve silk producing countries
- Traditional know how and skills are being lost in EU
- EU should contribute with knowledge-based approaches (biotechnology?)

The silk industry shares the same R&D needs and priorities of the whole EU T&C sector for what concern:

- Innovation (knowledge based high-tech process and technologies)
- Sustainability (health, environment)
- Qualified human resources

# Silk Division: Activity for the Benefit of the Textile Sector

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**R&D** — Testing, R&D Projects → *New Products, Processes and Services*

**Training** — Master, PhD, Post-Doc → *Qualified Human Resources*

**Networking** — Regional, National, EU Agencies → *System Integration Internationalization*

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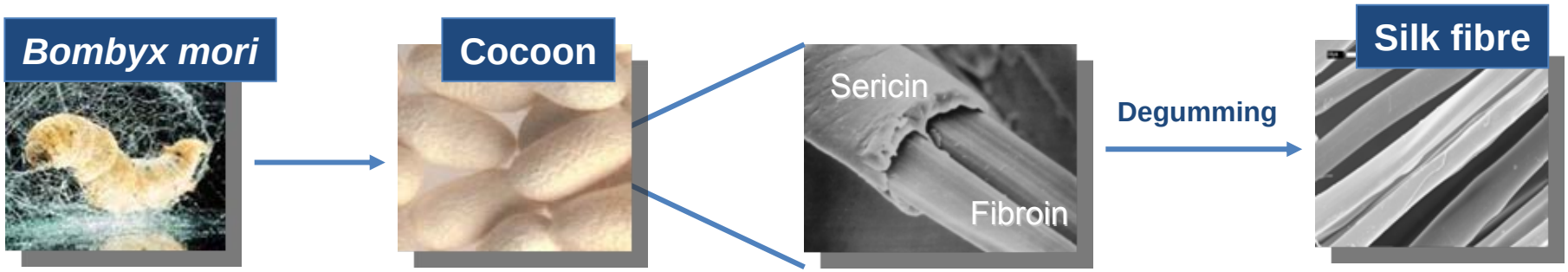
# Silk: an extraordinary natural fibre for textile and medical applications




## Properties:

- Excellent mechanical properties
- Excellent biocompatibility
- Controlled biodegradability
- Possibility to manufacture

# Processing options for silk fibres

## Traditional textiles

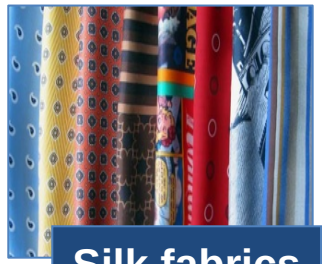
SF fibres

Textile processing

- Woven
- Knitted
- Braided
- ……

Solubilization

Silk solution

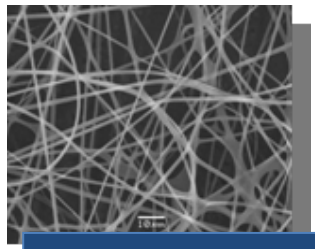


Silk fabrics

SF film

SF hydrogel

SF sponge

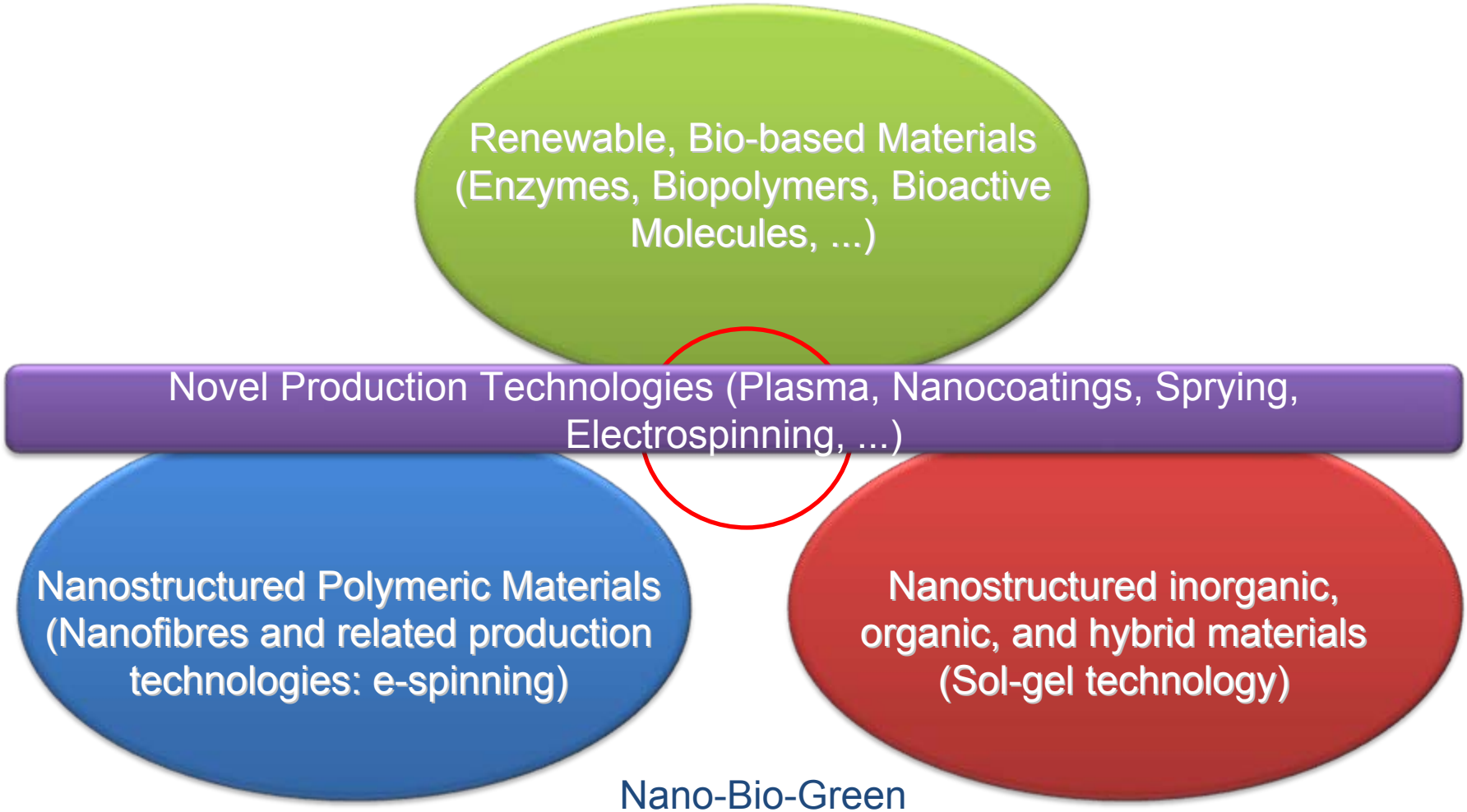


SF nanofibres

Braid

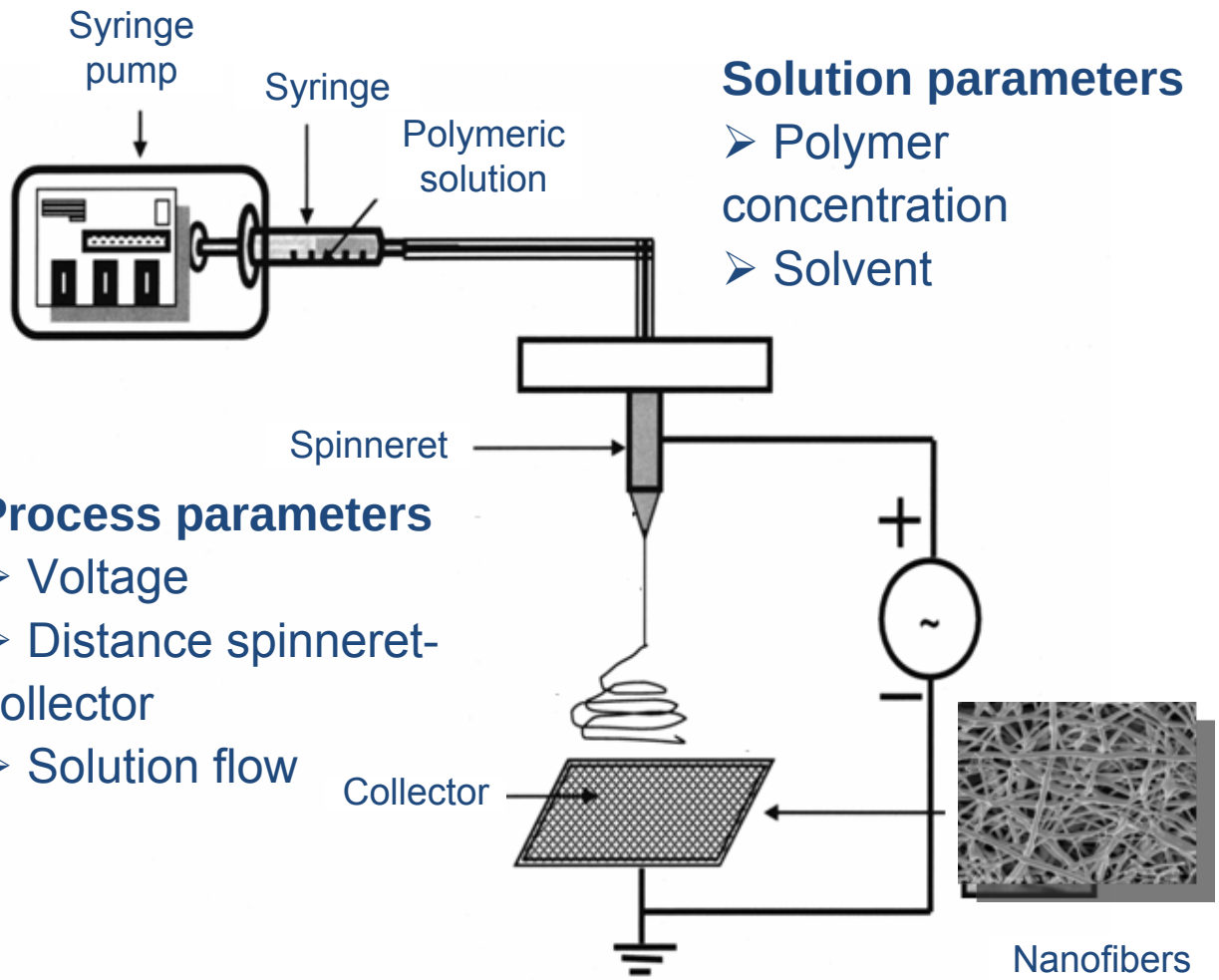
## Biomedical device

# Silk Division: Research & Development Strategy




Nano-Bio-Green

# Electrospinning Technology

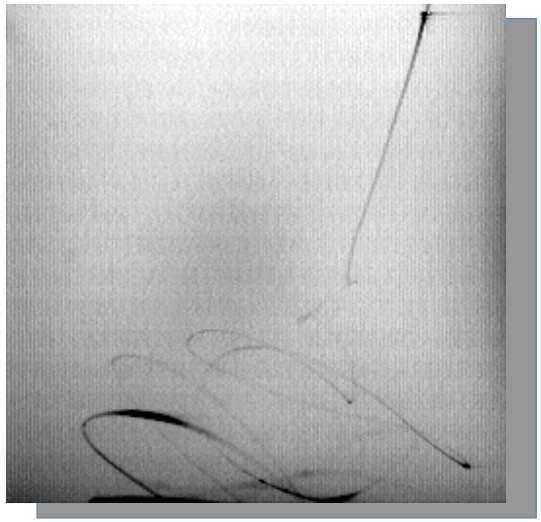



**Solution parameters**

- Polymer concentration
- Solvent

**Process parameters**

- Voltage
- Distance spinneret-collector
- Solution flow



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# Textile Projects Based on Nano and Biotechnologies

**INDES – Industrial electrospinning (Public funding)**

- The aim is to develop an industrial machine for the deposition of nanofibres onto the surface of yarns for their functionalization

**GreenMade - Innovation and sustainability in the textile finishing (Public fundin**

- The aim is to develop enzymatic processes in sobstitution of harsh chemical processes

**BioNanoSol - Textile functionalization and finishing by sol-gel technology (Public funding)**

**BIOinNANO – Multifunctional Textile Materials through Nano end Biotechnologies (Public funding)**

- The aim is to develop ceramic coatings for the surface functionalization of textile materials

**SilkBioTech – Biotechnological production of antimicrobial silk fibres (Public fu**

- See the poster of the project

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# Biomedical projects using silk as biomaterial

## BIOLEG – VASCOSILK - WINPIPE

- Public (BIOLG and VASCOSILK) or private (WINDPIPE) funding
- The aim is to develop a **prothesis** for Tendons and Ligaments (BIOLEG), for small calibre blood vessels (VASCOSILK) or for the trachea (WINDPIPE)
- The silk device must work according to Tissue Engineering concepts
- Starting materials: Degummed silk fibres for BIOLEG, Silk fibroin nanofibres for VASCOSILK and Silk fibroin nanofibres and polyurethane foams for WINDPIPE

# BIOLEG Project

## The silk ACL:

- Hierarchical structure
- Combination of knitting and braiding technologies
- Requirements to fulfil:
  - Mechanical performance (≥ of natural ACL)
  - Porosity (to allow cell infiltration and new tissue deposition)
  - Biocompatibility and slow biodegradability


Patent: EP2210971 (A1) — 2010-07-28

***In vivo* pre-clinical tests on animal model are now in progress**

# VASCOSILK Project

## The tissue engineering concept:

- The silk vessel must perform like a natural blood vessel (resistance to blood pressure)
- The silk device must allow regeneration of a novel and functional blood vessel tissue



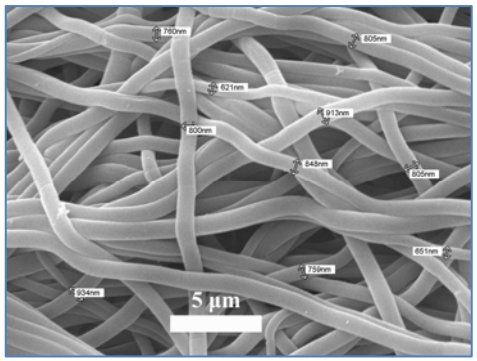
(Ø = 1.5 – 6 mm)


(Length = 10-15 cm)

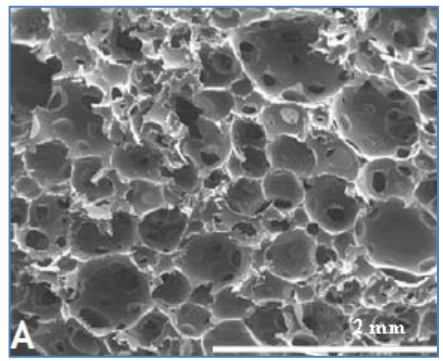
# WINDPIPE Project

**Activity in progress**:

- To combine different polymer materials (silk fibroin nanofibres and polyurethane foam)
- To develop a 3D device by combining elettrospinning e moulding techniques
- To validate the device from the morphological, mechanical, and biological point of view




Silk fibroin nanofibres




Polyurethane foam

# Contacts

For additional details on activity and research projects please contact:

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Thanks for your attention

# Activity of the Silk Division of Innovhub

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