RESET
Interreg Europe

European Good Manufacturing Practices in Smart textiles and new ways of production

Nanostructured textiles to promote skin repair in severe burn injuries

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Instituto de Investigación Sanitaria - IIS La Fe / AITEX

4th RESET Seminar on
"Smart textiles and new ways of production"
Chemnitz, 20th June 2017

European Union
European Regional Development Fund

SUMMARY

1. GMP STATE-OF-THE ART: TEXTILE RE-INDUSTRIALIZATION IN THE VALENCIAN REGION AND SOME SUCCESFUL CASES.

2. ELECTROSPINNING TECHNOLOGY AND PRODUCTION OF BIO-RESPONSIVE ELECTROSPUN MATS

3. RESULTS COMING FROM PRE-CLINICAL TRIALS.

4. CLOSING REMARKS AND NEXT STEPS.

1. GMP STATE-OF-THE ART: TEXTILE RE-INDUSTRIALIZATION IN THE VALENCIAN REGION AND SOME SUCCESFUL CASES

Situation of the Spanish and Valencian textile industry last 10 years:

Spanish market consumption of textiles ↑ **20%**

National production ↓ **29%**

Employment ↓ **35%**

Some lacks in terms of:

- Technification of processes and products
- Re-industrialization needs
- 'Traditional' production of 'traditional' textile products (e.g. nonwovens).

Some **funding instruments** are available for national/Valencian textile companies, in order **to improve machinery**, to promote **diversification** of the production and **to reduce lacks in terms of technology level**: REINDUS -national- and CREATEC -Valencia- programmes (co-funded by ERDF EU funds) or the Industrial Modernization Plan -Valencia-.

1. GMP STATE-OF-THE ART: TEXTILE RE-INDUSTRIALIZATION IN THE VALENCIAN REGION AND SOME SUCCESFUL CASES

Some companies and entities are doing **R&D, manufacturing and investing** on **new technologies and new ways of production**:

Clean technologies for textile finishing (JEANOLOGIA, S.L.)

FUN2GARMENT project - New functional and sustainable finishings for fabrics and garments (AITEX)

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Development of electrospinning technology (BIOINICIA, S.L.)

STENT-NET project - Development of drug eluting stents using biocompatible nanofiber meshes obtined by electrospinning (AITEX/IIS La Fe)

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Oil-enriched new wound dressings for treatment of chronic ulcers and burn skin injuries (AITEX/Solutex/IIS La Fe)

resoltex
Instituto de Investigación Sanitaria La Fe
aitex
Solutex

1. GMP STATE-OF-THE ART: TEXTILE RE-INDUSTRIALIZATION IN THE VALENCIAN REGION AND SOME SUCCESFUL CASES

They are also developing **'classical' smart-textiles, wearables, printed electronics** and promoting the concept '**Industry 4.0**':

SPORT@FUTURE project - New textile and footwear solutions to improve safety, protection, comfort, efficiency and health of the sportive people (partnership: 7 companies)

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CDTI Centro para el Desarrollo Tecnológico Industrial
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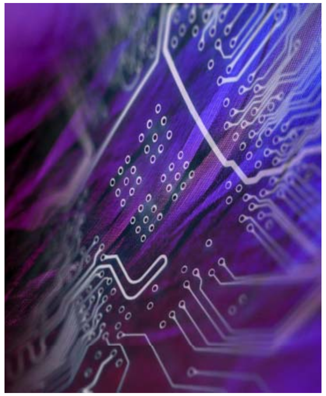

INSTINTO II project - Smart system based on sensors and actuators integrated into textiles for the purposes of preventing, detecting and protecting against a fall by an elderly wearer (AITEX)

SCREENTEX II - Printed electronics on flexible substrates (AITEX)

DIGITALIZA-T project: Industry 4.0 Textile sector (AITEX)

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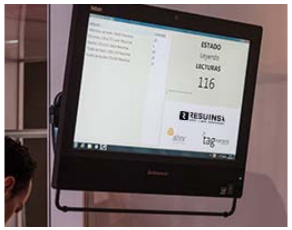

iTEX4HOTEL - Implantation of RFID technology in textile items for the hotel industry (RESUINSA EXPERIENCES S.L.)

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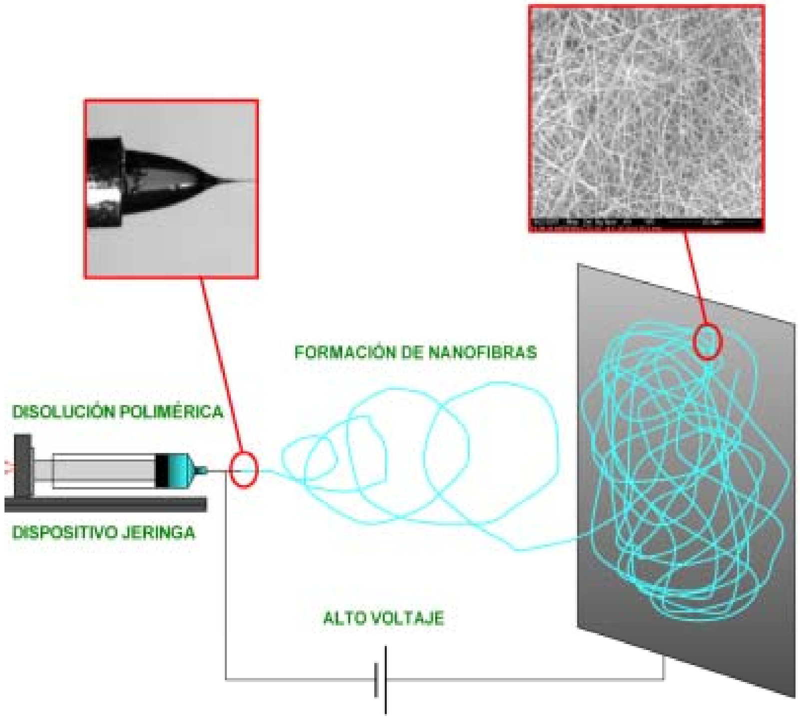
2. ELECTROSPINNING TECHNOLOGY AND PRODUCTION OF BIO-RESPONSIVE ELECTROSPUN MATS

Electrospinning (ES) is a widely used technology **to develop nanofibers and meshes**:

- **Electrospinning** is a fiber production method which uses electric force to draw charged threads of polymer solutions up to nanometrical fibers
- The process does not require the use of coagulation chemistry or high temperatures to produce solid threads from solution.
- This makes the process particularly suited to the production of fibers using large and complex molecules; this method ensures that no solvent can be carried over into the final product.

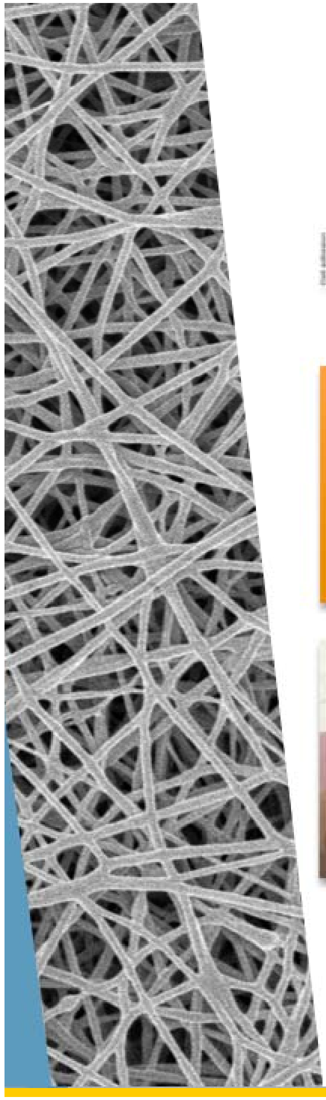
2. ELECTROSPINNING TECHNOLOGY AND PRODUCTION OF BIO-RESPONSIVE ELECTROSPUN MATS

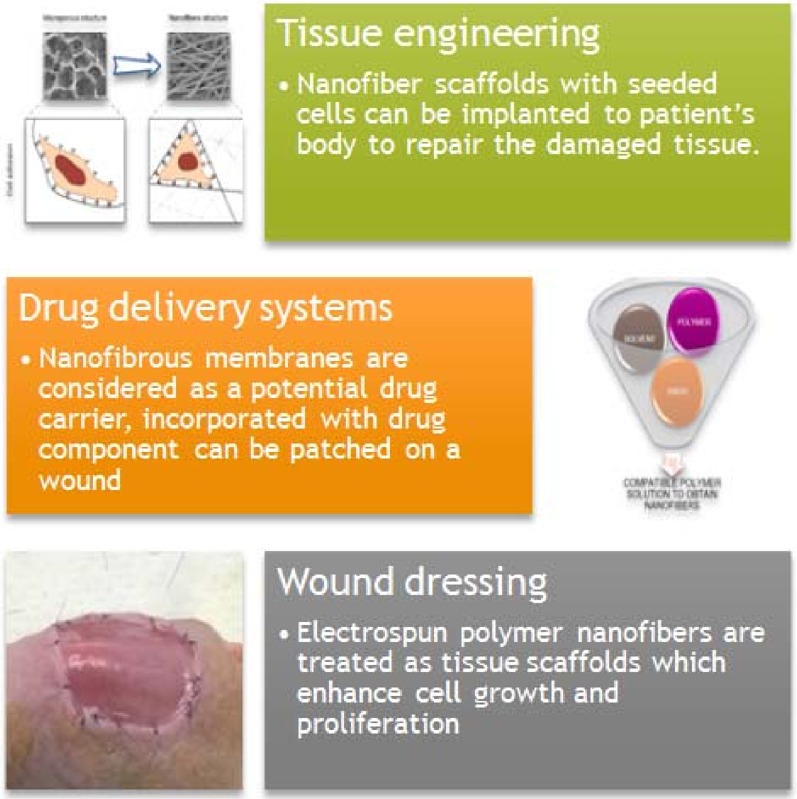
Different electrospinning devices are available in the market: from easy-to-operate needle-based small devices (e.g. **biomaterials**) to wide formats (production of **industrial goods**: **filtration or acoustic materials, membranes**…).



Polymers for bio-responsive applications and biomedicine must be selected from '**medical grades**'. Here we focus on the treatment of severe burn injuries using electrospun mats (monoaxial) of **bio-compatible poly(D,L-lactide-co-glycolide) (DLPLG)**.

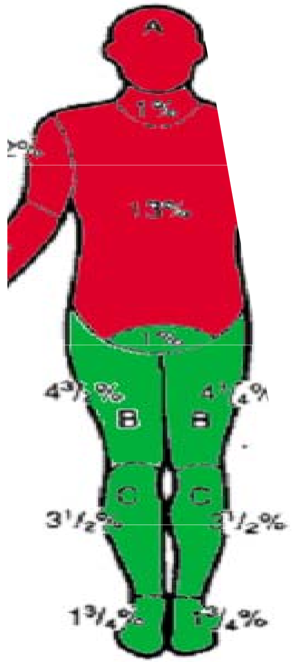
2. ELECTROSPINNING TECHNOLOGY AND PRODUCTION OF BIO-RESPONSIVE ELECTROSPUN MATS





- Electrospinning technnology allows generation of biomaterials with tailor-made thickness and dimensions.
- **Nanofiber webs or mats have a specific area and porosity** controlled by altering the weight and density of fibers by surface unit allowing the adaptation of scaffolds to a particular **tissue engineering application.**

3. RESULTS COMING FROM PRE-CLINICAL TRIALS.



Options for treating severe burn injuries:

- If burn area is **< 50% of total body area**

Best option are AUTOLOGOUS SKIN GRAFTS

- If burn area is **> 50% of total body area**

Unique option is AUTOLOGOUS *ex vivo* EXPANDED DERMAL EQUIVALENT

<u>Current dermal equivalents</u>:
A healthy skin biopsy is taken from the patient and expanded *ex vivo* in a GMP cell culture room to obtain artificial skin from the same patient that will be transplated as a definitive cover

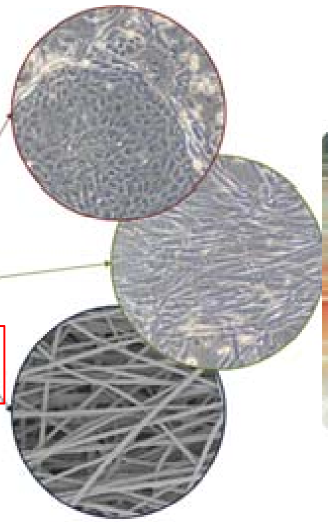
+	−
Definitive coverage	Preparation time
Economic	Handling
Good results	Sensitive to infection
	Irregular performance

3. RESULTS COMING FROM PRE-CLINICAL TRIALS.

The main objective of the nanostructured textiles -scaffolds- is to improve the quality of dermal equivalents and to increase their viability and engraftment.

Electrospun scaffolds must fulfill the following requirements:

- Do not cause cell death or be toxic or teratogenic.
- To promote cell adhesion and proliferation.
- To allow homogeneous and continuous cell growth.
- To be biodegradable and biocompatible.
- Do not induce chronic inflammation
- Be sterilizable and easy to handle.



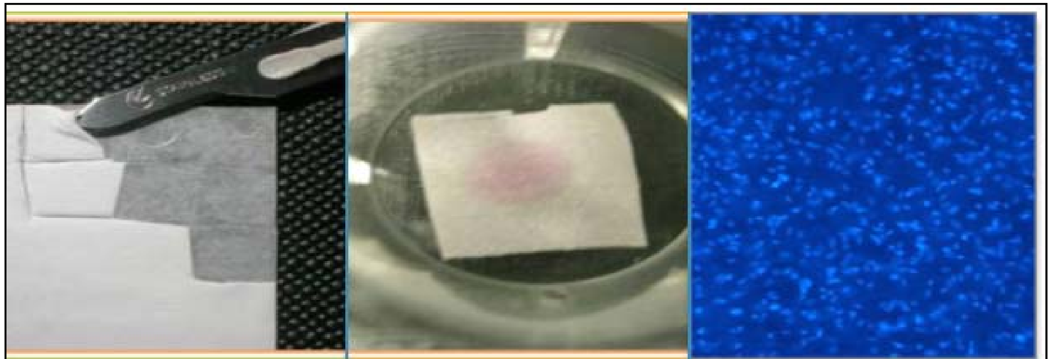
The product generated in this project consists of a electrospun scaffold combined with a dermal equivalent made of fibroblasts and keratinocytes:

- ***It provides improved handling of dermal equivalent (DE)***
- ***It improves engraftment of DE.***
- ***It can be functionalized with growth factors, antibiotics or other active principles.***

3. RESULTS COMING FROM PRE-CLINICAL TRIALS.

Testing. In vitro cellular assays and in-vivo (animal, mices) models:

<u>In vitro cellular assays</u>:



Nanofiber web	Culture well	Cells growing on nanofiber web

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RESEARCH ARTICLE

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Electrospun poly(hydroxybutyrate) scaffolds promote engraftment of human skin equivalents via macrophage M2 polarization and angiogenesis

Delia Castellano[1,2†], Ana Sanchis[1†], María Blanes[3], Mª. Dolores Pérez del Caz[1], Amparo Ruiz-Saurí[4], Marina Piquer-Gil[1,2], Beatriz Pelacho[5], Bruno Marco[3], Nahuel Garcia[1,2], Imelda Ontoria-Oviedo[1,2], Vicente Cambra[3], Felipe Prosper[5] and Pilar Sepúlveda[1,2*]

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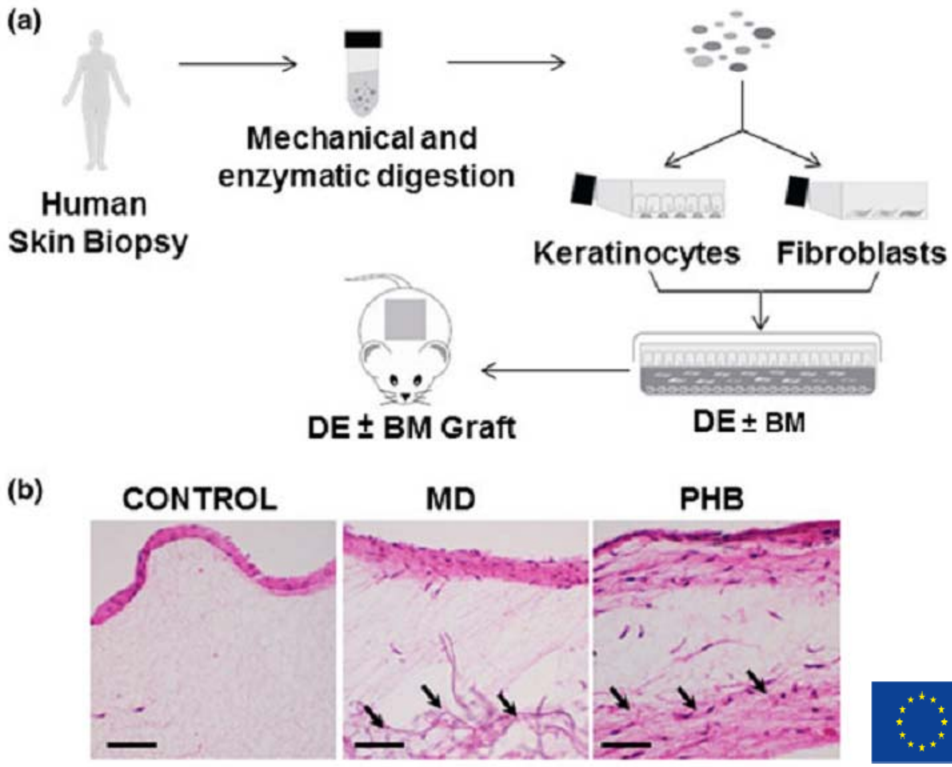

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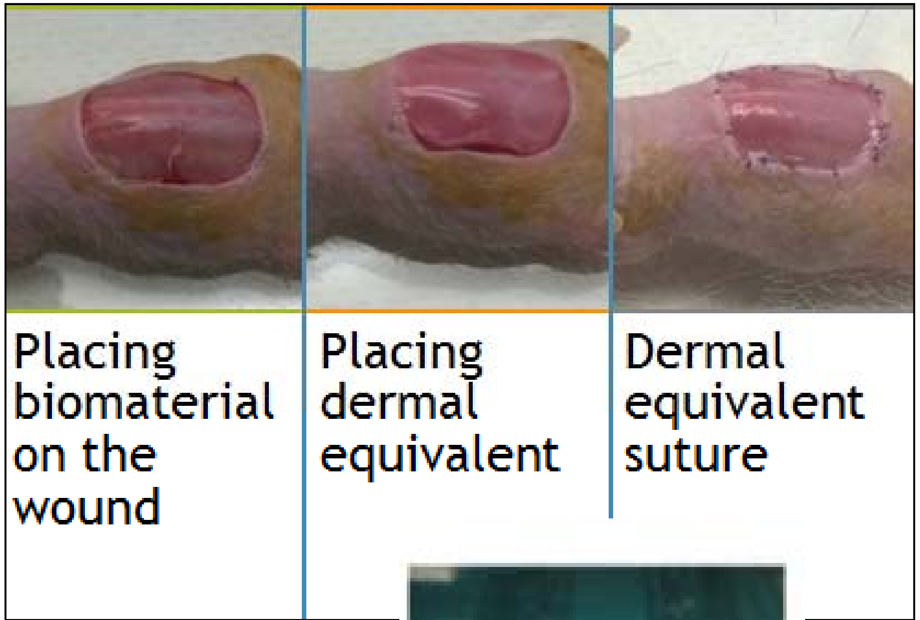
3. RESULTS COMING FROM PRE-CLINICAL TRIALS.

In vitro cellular assays and **in-vivo** mouse models:

<u>In vivo NOD/SCID mice</u>:



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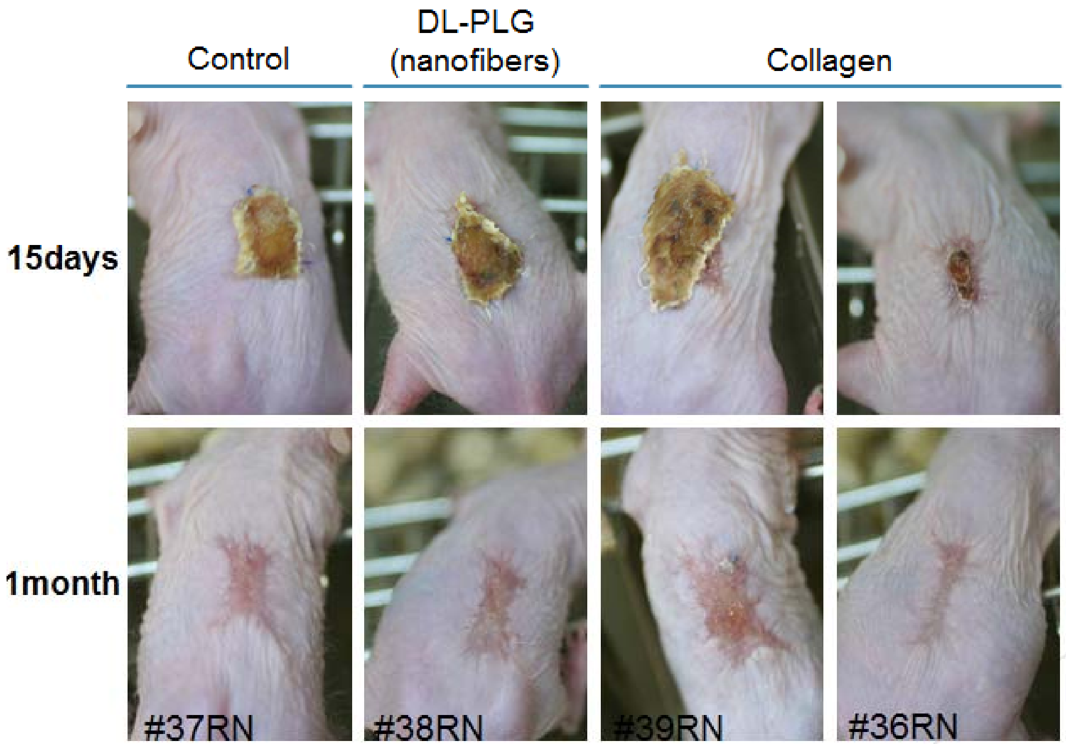

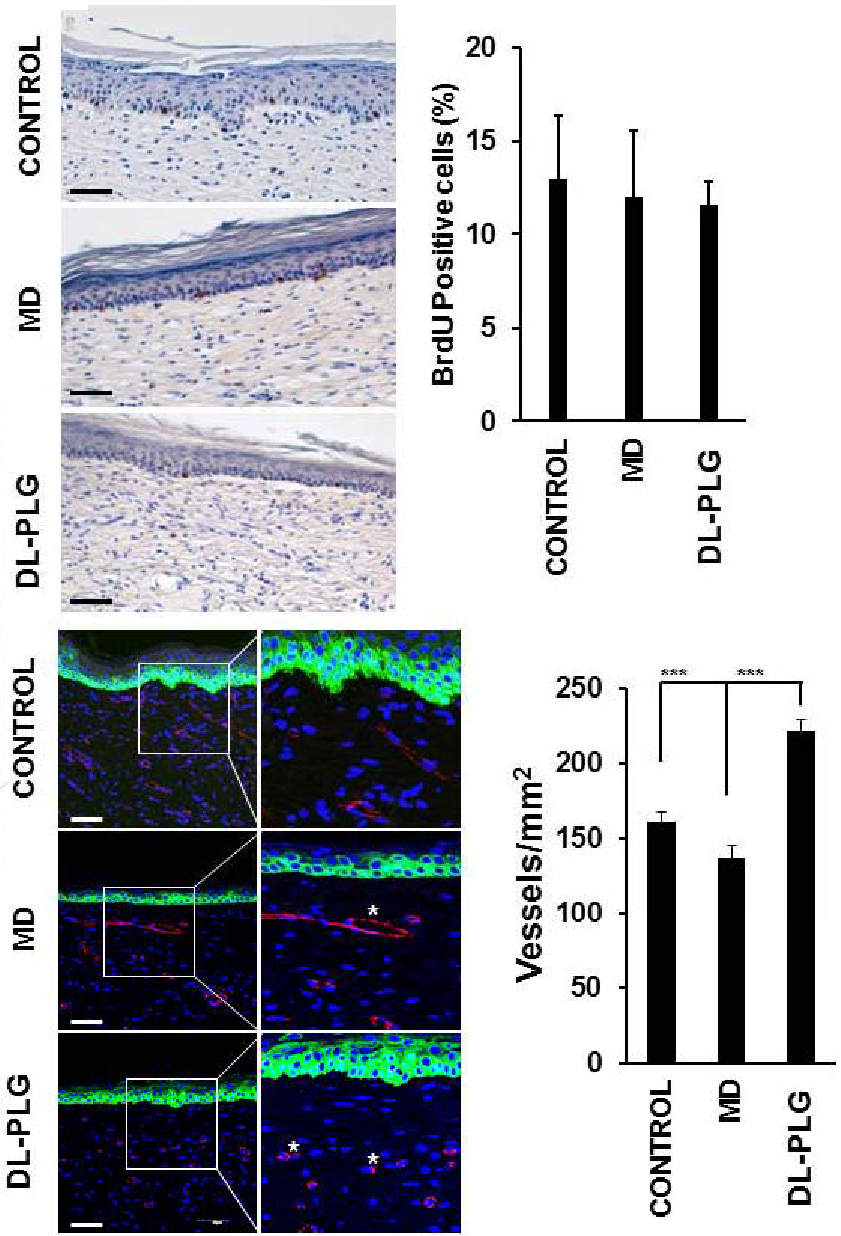

DL-PLG nanotextiles promote better cell growth and provide less tension and smoother skin surface than common regenerative solutions. In addition, they also improve the scar quality.

4. CLOSING REMARKS AND NEXT STEPS.

- Biomaterials tyested are biocompatible in terms of controled inflammation and cell growth
- Nanofibers **integrate into fibrin matrix** and are **permeable to nutrients and cells.**
- New dermal equivalents with nanofibers are **optimal for clinical handling.**
- New dermal equivalents have **angiogenic capacity** (promotes **formation of new blood vessels**).
- They **improve scar quality, less tension, smooth surface.**
- **They could be improved by adding drugs or growing factors.**

4. CLOSING REMARKS AND NEXT STEPS.

Instituto de Investigación Sanitaria La Fe

IIS la Fe
- Biologic characterization
- Setting up of the animal models

aitex textile research institute

AITEX
- Scaffold development
- Material selection and processation

NEXT STEP…

NEW DERMAL EQUIVALENT
- Clinical trial validation

Bioinicia and FLUIDNATEK

INDUSTRIAL PRODUCTION OF NANOSTRUCTURED TEXTILES

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THANK YOU FOR YOUR ATTENTION!!!

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