Nanotechnologies as a key factor in the development of sustainable and cost-effective products

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Summary

Some words about CeNTI
Nanocomposites synthesis
Nanotechnologies for finishing
Use of advanced materials
Benefits over conventional technologies
Three Main Competence Pillars

- Functional Materials & Solutions
- Smart Materials & Systems
- Modelling Design & Engineering
‘Three steps’ philosophy

R&D
- Proof-of-concept
- 1st Process approach
- 1st Cost Assessment

Prototyping
- Product Design
- Process Refining
- Cost Assessment

Pre-series co-production
- Market Proof
- Pre series
Many Substrates

- Textile
- Leather
- Paper
- Ceramics
- Wood
- Concrete
- Cork
- Glass
- Polymers
Nanotechnologies as a key factor in the development of sustainable and cost-effective products
Challenges

- Resources depletion / competition
- Climate changes
- Energy consumption increase
- Informed consumers
- Customized products and services
- Sustainability and social & environmental responsibility
Strategy

- Development of new materials & processes
- Multifunctionality
- Sustainability
- Resources minimization (raw materials, water & energy)
- Replacement of critical materials (supply issues and/or environmental or safety risks)
Nanotechnologies Value Chain

New Materials
- Nanomaterials / nanocomposites

New Processes
- Nanotechnologies

New Products
- Advanced materials / processes
New nanomaterials:
- Synthesis of new nanomaterials / nanocomposites
- Examples - nanomaterials for:
  - super oleophobic
  - antimicrobial
  - scratch resistant
  - anti-static and conductive
  - magnetic
  - anti-counterfeiting …
SiO$_2$ - based nanocomposite synthesis

- Functionalizing molecules:
  - TiO$_2$ for Self-cleaning
  - Fluorocarbons for repellency
  - Inorganic/Organic phosphorous for FR
  - Inorganic/Organic molecules for Photochromic
  - Inorganic/Organic molecules for IR Reflection
  - …
Nanomaterials synthesis

Nanomaterials characterization:
Nanomaterials synthesis

Agricultural residues as silica source

Lab scale

Pilot scale
2L & 10L

Pilot scale
100L & 650L
Nanomaterials synthesis

Self-Cleaning textiles – CeNTI approach
New processes

- Plasma
- Ozone
- Ultrasound deposition
- Green chemistry
- ...

- New functionalities
- Improved adhesion / performance
- Improved process conditions
- Cost savings (energy, effluents treatment, …)
Plasma treatments

- Substrate pre-treatment for efficient incorporation of nanomaterials
- Used to clean or activate the surface (chemical plasma)

Plasma pre-treatment stations (0.5m and 2m wide)
Plasma treatments

➢ improved adhesion / performance

Untreated PP

Treated PP
➢ Ultrasonic spraying assures that functional nanocoating is deposited onto the substrate surface – no residues
➢ Change from a wet process to a “dry” process – savings in water, chemicals and energy (up to 80%)
➢ Substrate inherent properties are kept, while new functionalities are attained
Repellent nanolayers

- cofee
- ketchup
- olive oil
- red wine

Ultrasonic deposition

Control cotton

Cotton w/ FC NPs
Ultrasonic deposition

- Repellent nanolayers

Fabric exterior

Fabric interior

Synthetic blood

Water

Liquid paraffin
➢ Repellent nanolayers

➢ Contact angles higher than 150°

➢ Superhydrophobic and oleophobic surfaces
### Antimicrobial effect

<table>
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<th>S. Aureus Antimicrobial activity (ISO 20743)</th>
<th>1 wash cycle</th>
<th>30 wash cycles</th>
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<tbody>
<tr>
<td>Foulard impregnation</td>
<td>1,4 ± 0,1</td>
<td>1,2 ± 0,1</td>
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<tr>
<td>US deposition</td>
<td>1,85 ± 0,06</td>
<td>1,13 ± 0,09</td>
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- Natural antimicrobial agent applied only at interior side of the fabric
- Fabric was plasma pre-treated
Flame retardant treatment

Ultrasonic deposition

Control (CO)  US spraying, 10X  Foulard, 10X

<table>
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<th>Washing cycles</th>
<th>Total colour difference, $\Delta E$</th>
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<tr>
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Advanced materials & processes

- Advanced polymers and coatings
- Advanced fibers
- Advanced composites
- Advanced printing & integration of electronics...

- New functionalities
- Improved performance
- Cost savings (energy, effluents treatment, …)
New Fibers

Development / Production of bi-tricomponent fibers doped with nanomaterials
Printed Electronics

- Direct Printing of Intelligence
- Printed and Integrated Lighting Device
- Streachable
- Printed Flexible Sensor Actuator
- Flexible matrix
- Printed electronic circuits
Ceramic tiles with improved thermal comfort

COOLDOWN

Some examples

revgres®
Centre for Nanotechnology and Smart Materials

CENTI

PATENTED
Some examples

Ceramic tiles with improved thermal comfort

[Image showing comparison between MOSAICO/TILE and WARMUP MOSAICO/TILE]

[Image of a girl with a dog, labeled "revifeel"]

[Logos and text: revigres, CENTI, COMPETE 2020, PORTUGAL 2020, UNIÃO EUROPEIA Fondo Europeu de Desenvolvimento Regional]
On going projects

Cold touch and chrome looks without chromium

Chrome effect coating
Polymeric substrate

High gloss chrome effect coating functionalized with nanoparticles
Polymeric matrix with fillers
Other applications

- UV protection
- Flame retardance
- Easy/Self cleaning
- Thermal management
- Abrasion Resistance
- High temperatures resistance
Thank you for your attention

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