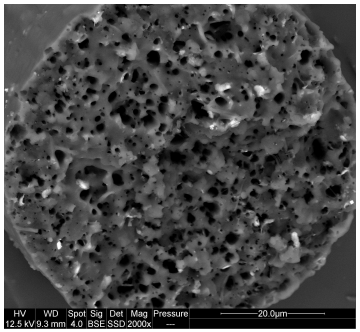
GEMTEX Annual Research Seminar

Development of multi-component fibers, by melt spinning, to develop the functionality of textile structures

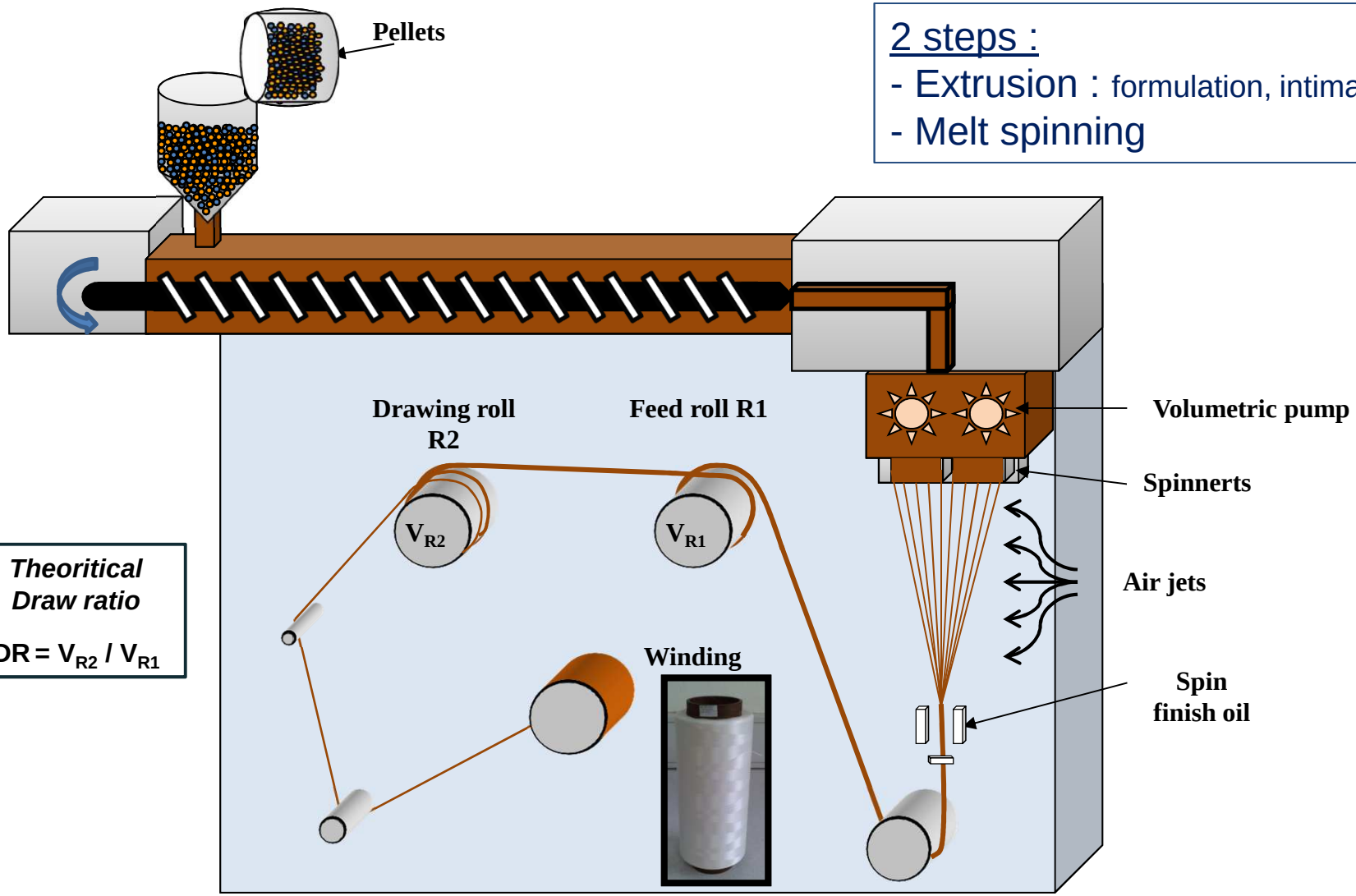
Interest in the use of immiscible polymer blends

Aurélie CAYLA



Fibers manufacturing by melt spinning → Bulk fonctionnalisation

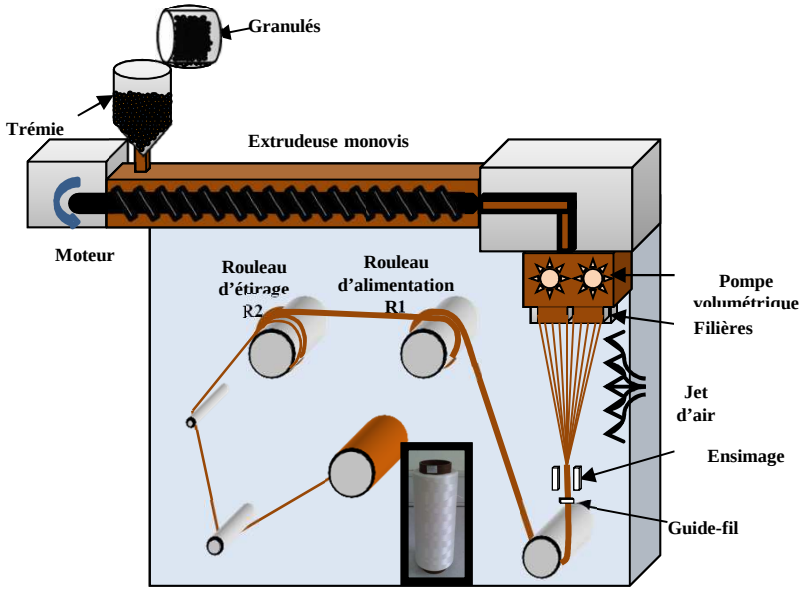
2 steps :
- Extrusion : formulation, intimate blend
- Melt spinning

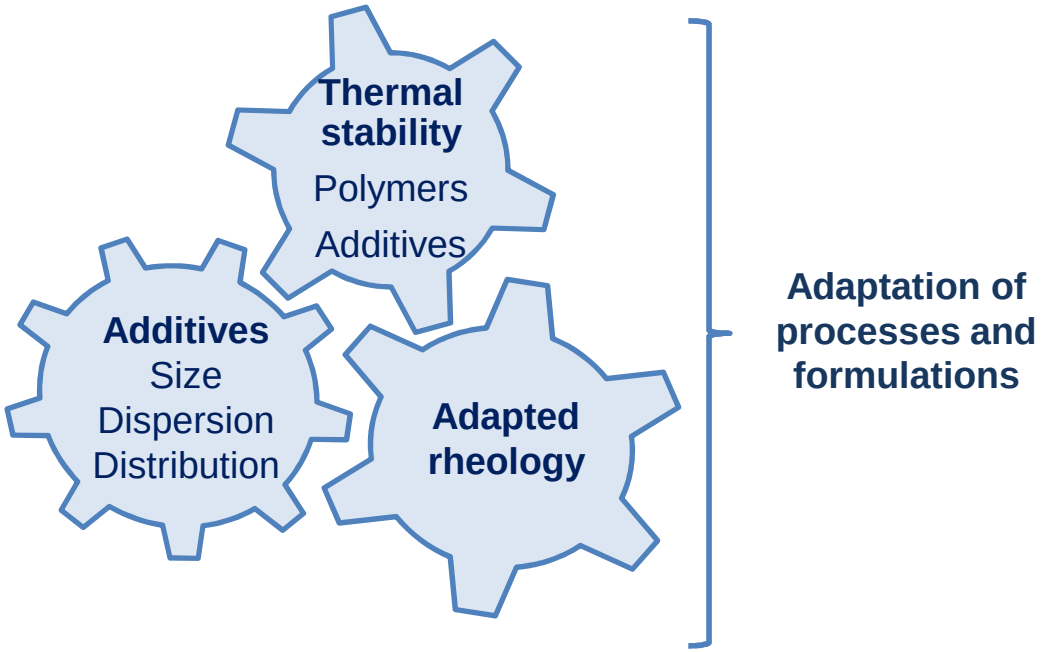


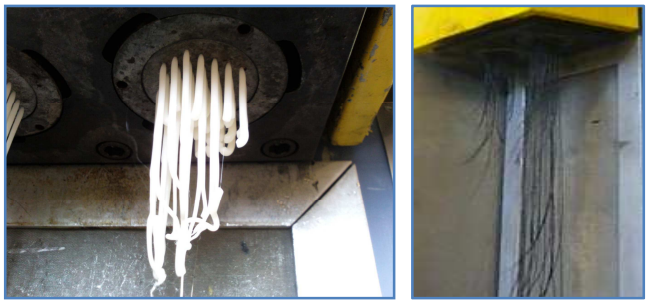
Theoritical Draw ratio

$DR = V_{R2} / V_{R1}$

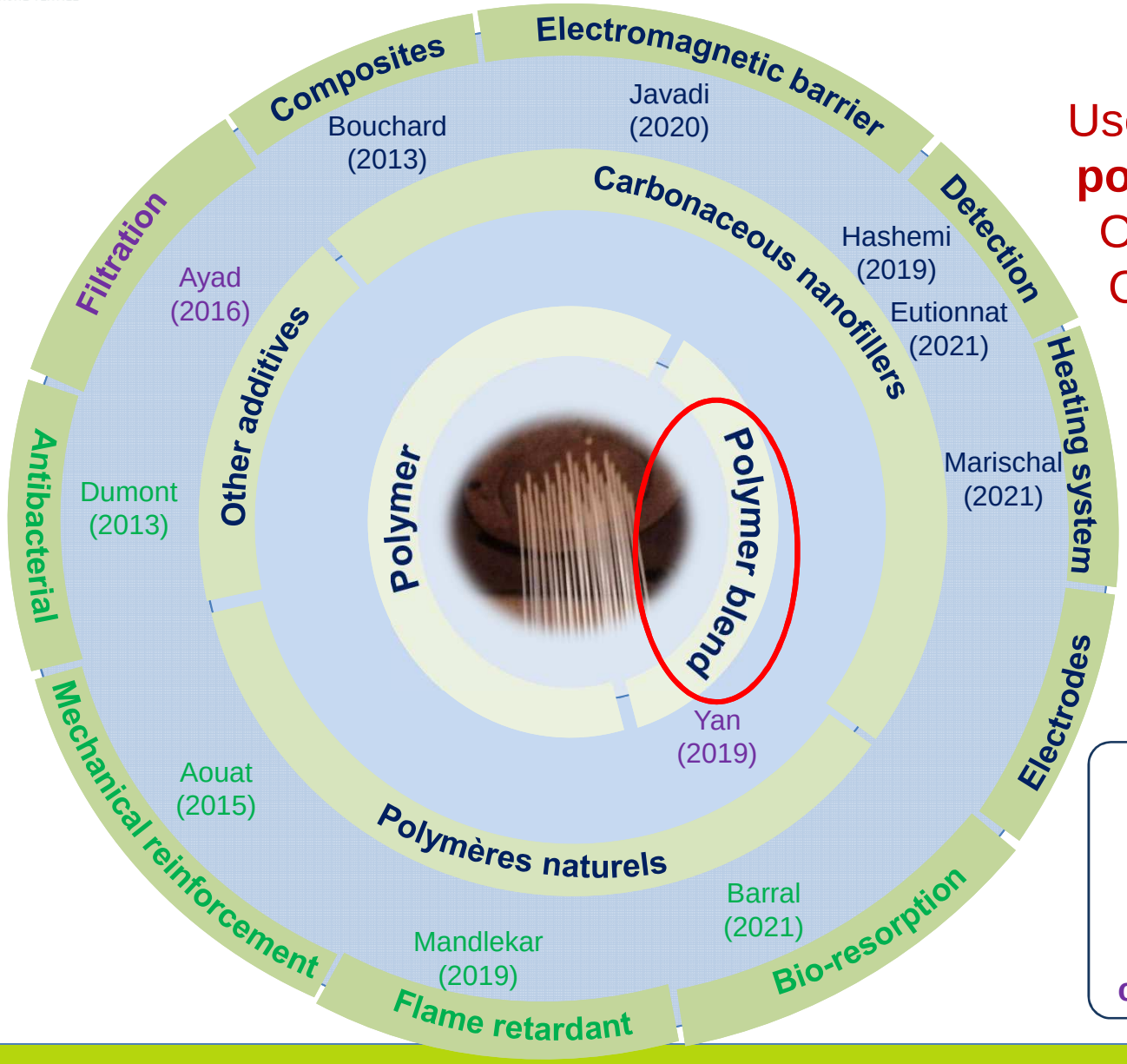
Melt spining process: technological / scientific locks







Needed process for bulk functionalization of filaments



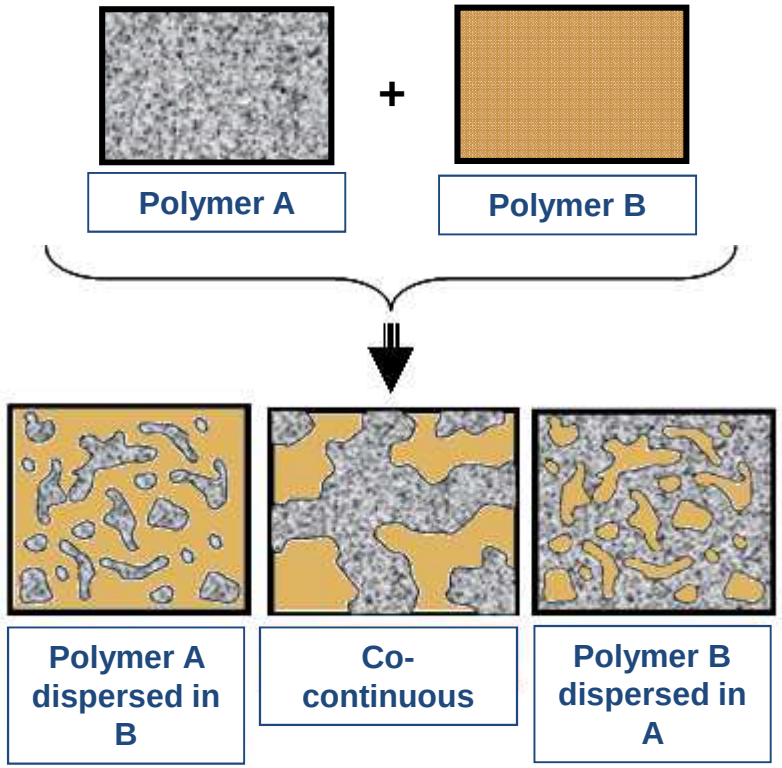
Use of **immiscible polymer blends** :
Opportunities…
Challenges ….

Conductive Polymer Composites

Sustainable filaments

Multicomponent with complex morphologies

Morphology of biphasic systems



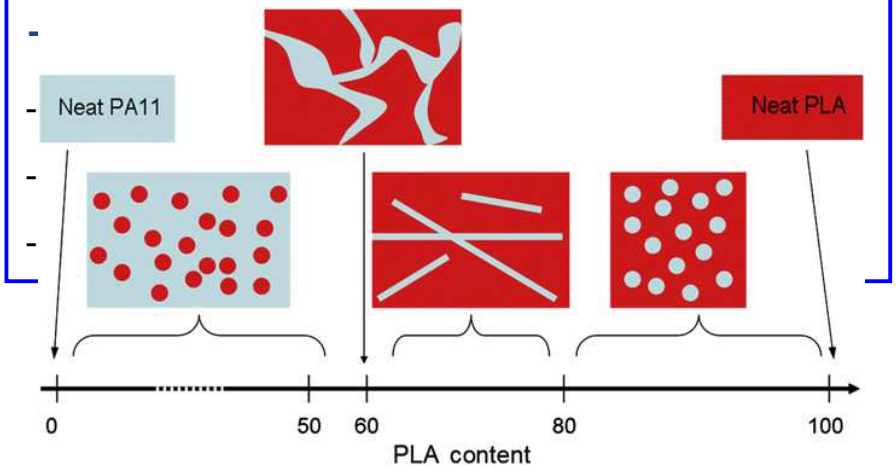
Governed by 2 phenomena:

Drop breakage and coalescence effect

Influencing parameters :

→*Intrinsic properties of the blend:*

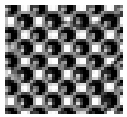
- viscosity ratio
- interfacial energy between the two polymers
- formulation



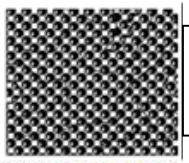
Fillers localization in a two-phase system

Co-continuous

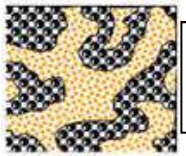
+



Fillers

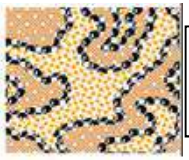


Fillers occupying both phases



Fillers occupying one of the two phases

Fillers occupying the second of the two phases



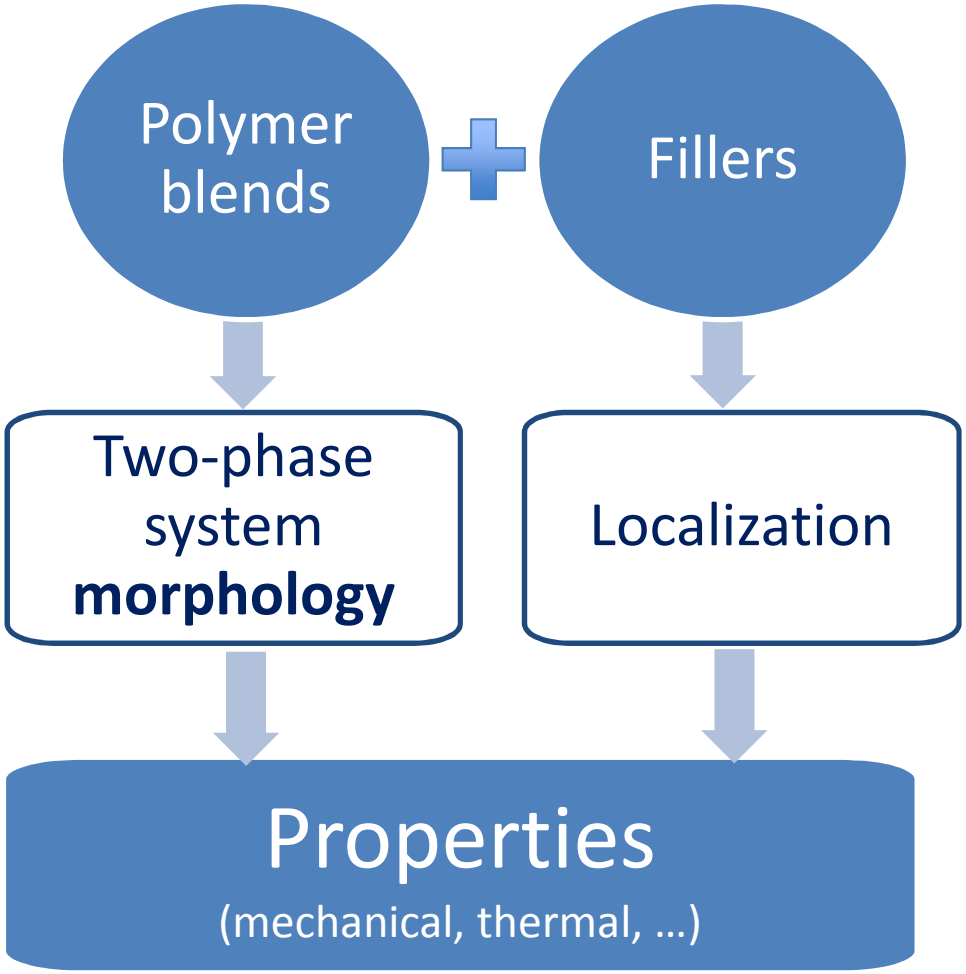
Fillers located at the interface

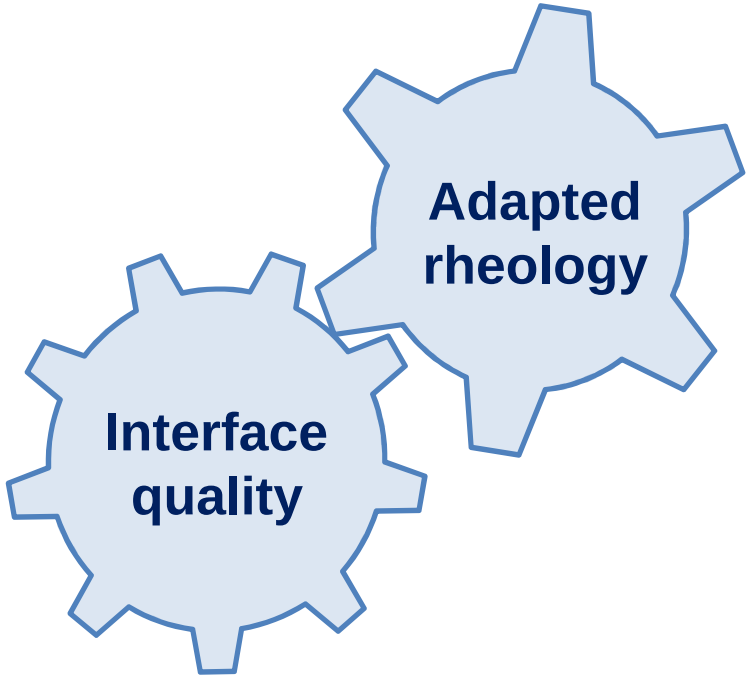
Paramètres influents :

→*implementation sequence*

→*surface energy of polymers*

→*viscosity ratio*

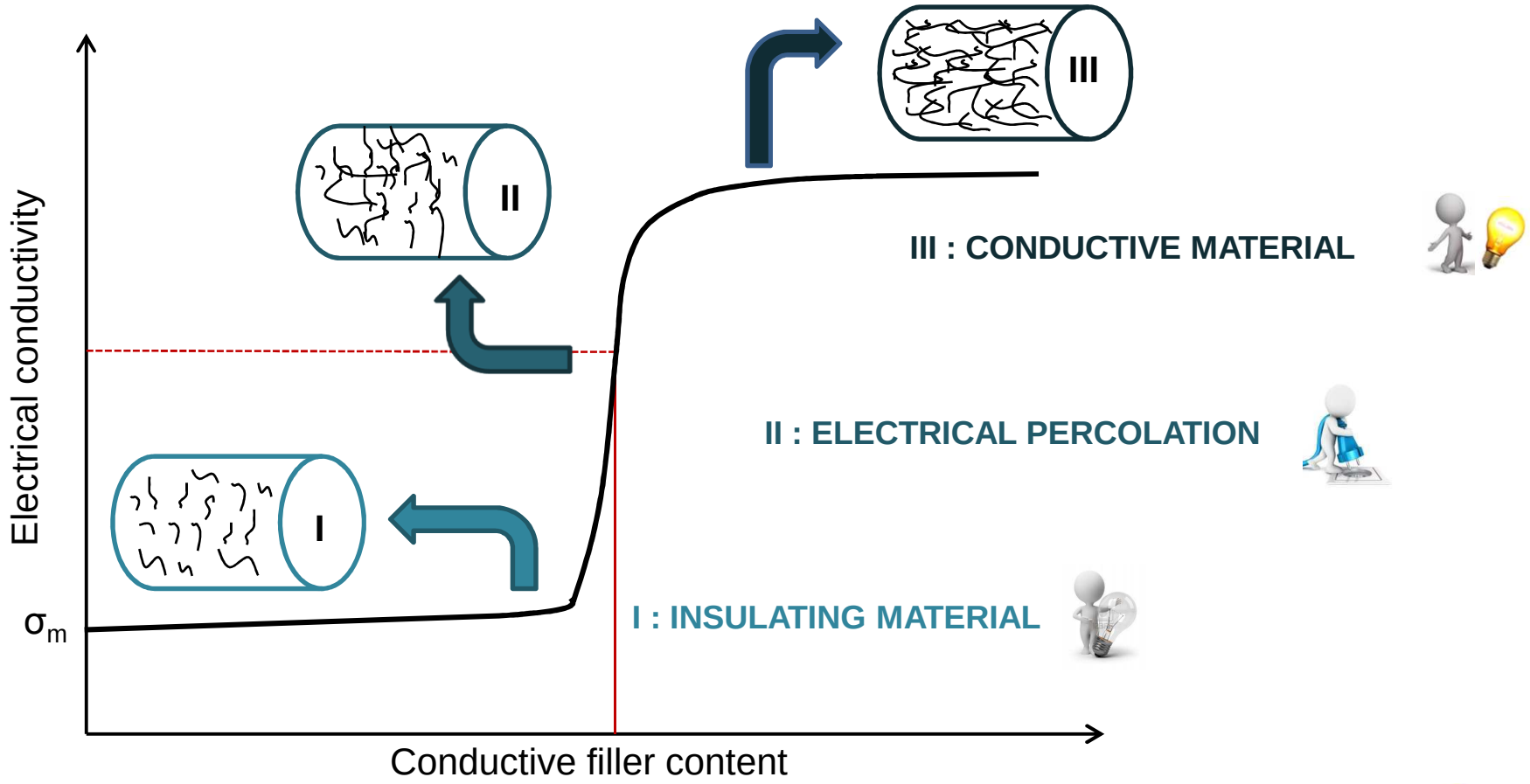




Conductive polymer composites | **Bio-degradable filaments** | **Porous filaments**

Conductive polymer composites (CPC)

Incorporation of conductive fillers into an insulating polymer matrix



Conductive polymer composites

Bio-degradable filaments | Porous filaments

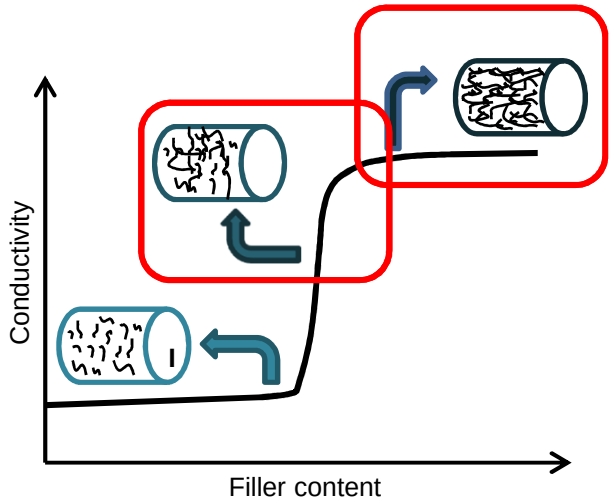
Electrical conductivity

Spinnability

Choice of materials (fillers, additives, polymer blends)

Adaptation of the implementation process

Electrical conductivity level according to the concerned property



High conductivity (>1 S/m)

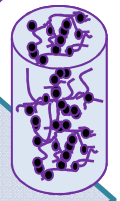
- Conductivity in composites
- Electromagnetic barrier

Implementation of various CPC formulation strategies

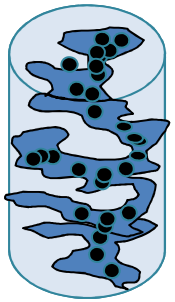
Average conductivity (~ 10^{-3} S/m)

- Detect stimuli:
  - Temperatures
  - Solvents
  - Mechanical stress

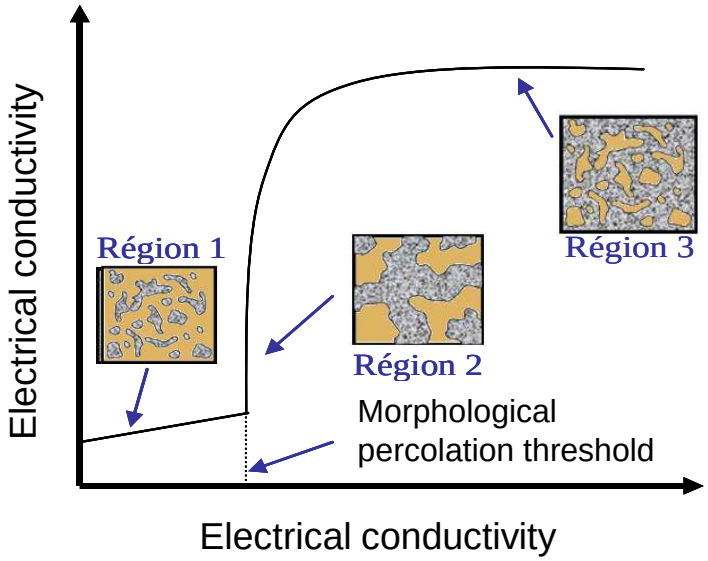
Nanocomposite Single-phase Single filler



Nanocomposite Single-phase **Fillers synergies**



Nanocomposite
Two-phases
Selective localization



Reduction of fillers content

Preservation of electrical conductivity

Less impact on the viscosity of the blend, increase processability.

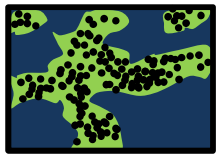
New applications

Conductive polymer composites | Bio-degradable filaments | Porous filaments

AUT THERM²

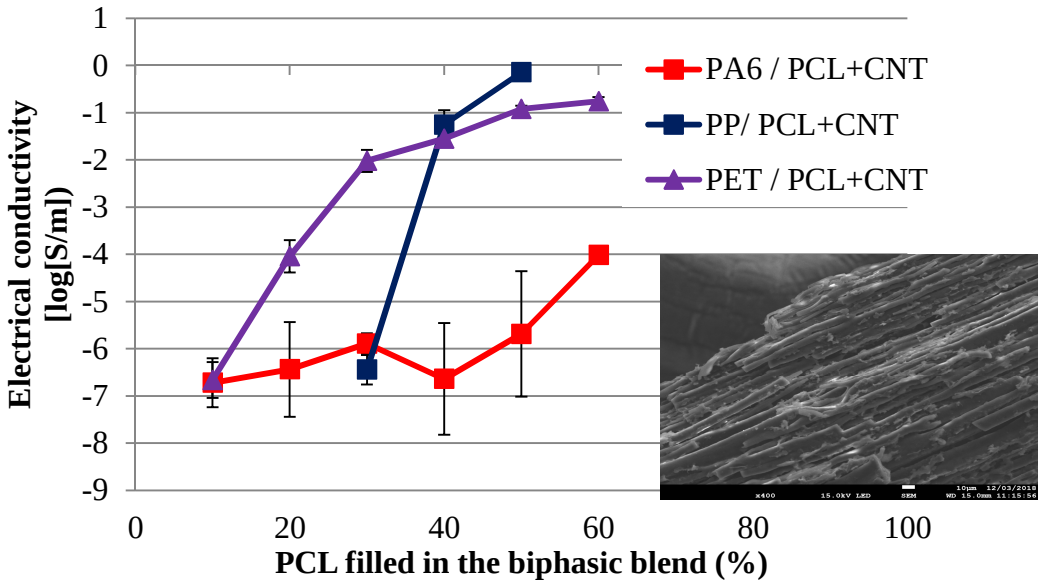
2018-2021

Development of self-regulation **heating** textile by **Joule effect**

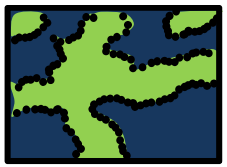


UPtex | DAMART La fibre du bien-être | gantmaille la protection textile | TECKNISOLAR | Centre Hospitalier Régional Universitaire de Lille | COUSIN Composites FIBERS IMPROVEMENT

Modification of electrical conductivity according to morphologies and localization



Future work :
Highest conductivity



Interreg France-Wallonie-Vlaanderen — UNION EUROPÉENNE EUROPESE UNIE

MAT(T)ISSE

*Matrices Textiles Tridimensionnelles pour autogreffes de tISSu adipeux dédiées à la reconstitution tissulairE

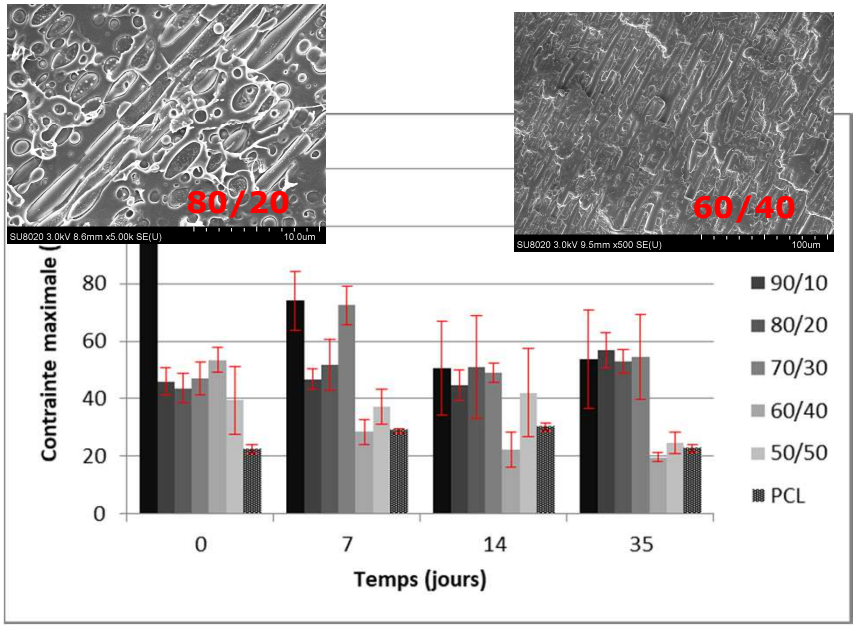
2017-2021

OBJECTIVE: To develop a resorbable textile support for breast prosthesis

UMONS Université de Mons — eurasanté Entreprendre et Réussir — Centre Hospitalier Régional Universitaire de Lille

MateriaNova MATERIALS R&D CENTRE — (UP tex — sirris

Immiscible blend of two biodegradable and biocompatible polymers : PLA/PCL



Link morphology to the evolution of mechanical properties during ageing

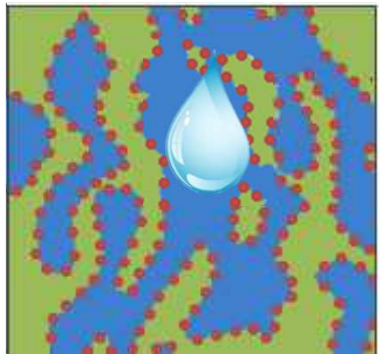
Future work :

Increase initial mechanical properties of blends

→ using a compatibilizer

Design of biphasic polymeric fiber from melt-spinning filled with nanoparticles to obtain a surface functionalized fiber

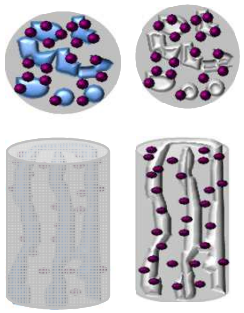
2016-2019



PP
PVA
Nanoparticules

Combination of polymer blend and nanocomposites

Surface functionalization of polypropylene fibers after extraction of a sacrificial polymer



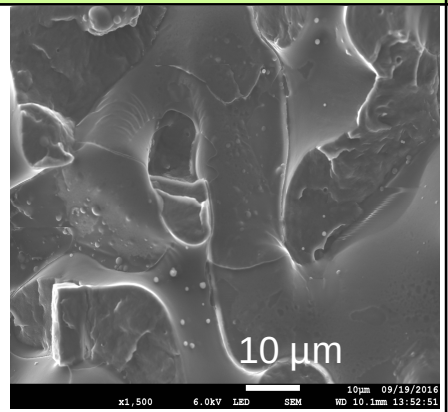
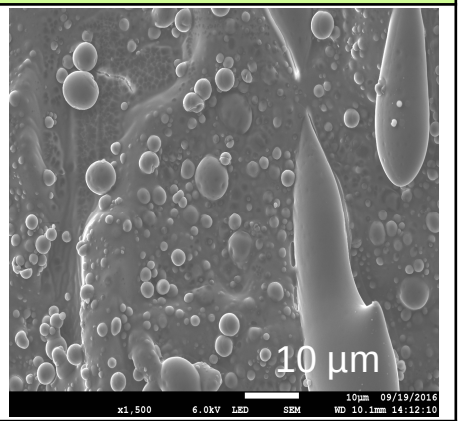
Evolution of morphologies

→*Ratio of polymers*

→*Filler content*

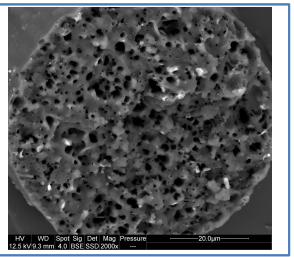
→*Surface energy of the fillers*

Wetting parameter

(PP/Silica1)/PVA	(PP/Silica2)/PVA
	
Co-continuous	**PP dispersed phase in PVA**

PP/PVA 70/30

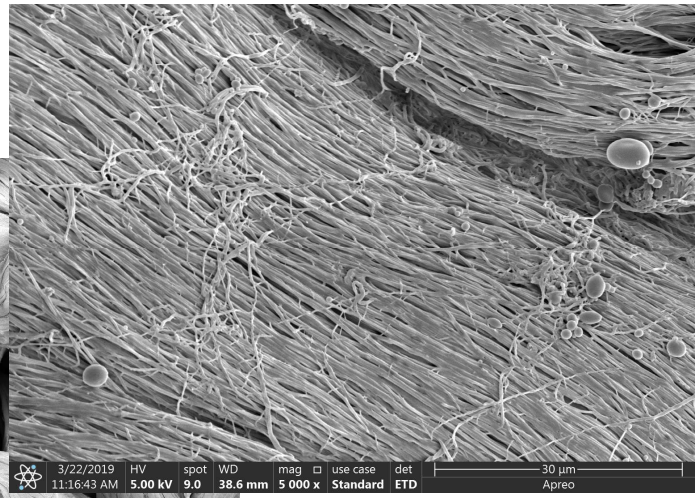
PP/PVA 70/30 → porous filaments



Inversion phase
PP/PVA 30/70

Before extraction

After extraction



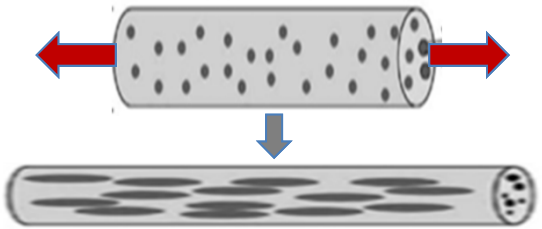
Nanofilaments
after extraction

Open to many applications :
Insulation
Filtration

Immiscible of polymer blends

↓

Design of morphologies in response to a property



Influence of the process on morphology (structure/fillers localization)

Rheological: flow effect

Interface management

Thank you for your attention