Photonitex School 07/11/2019

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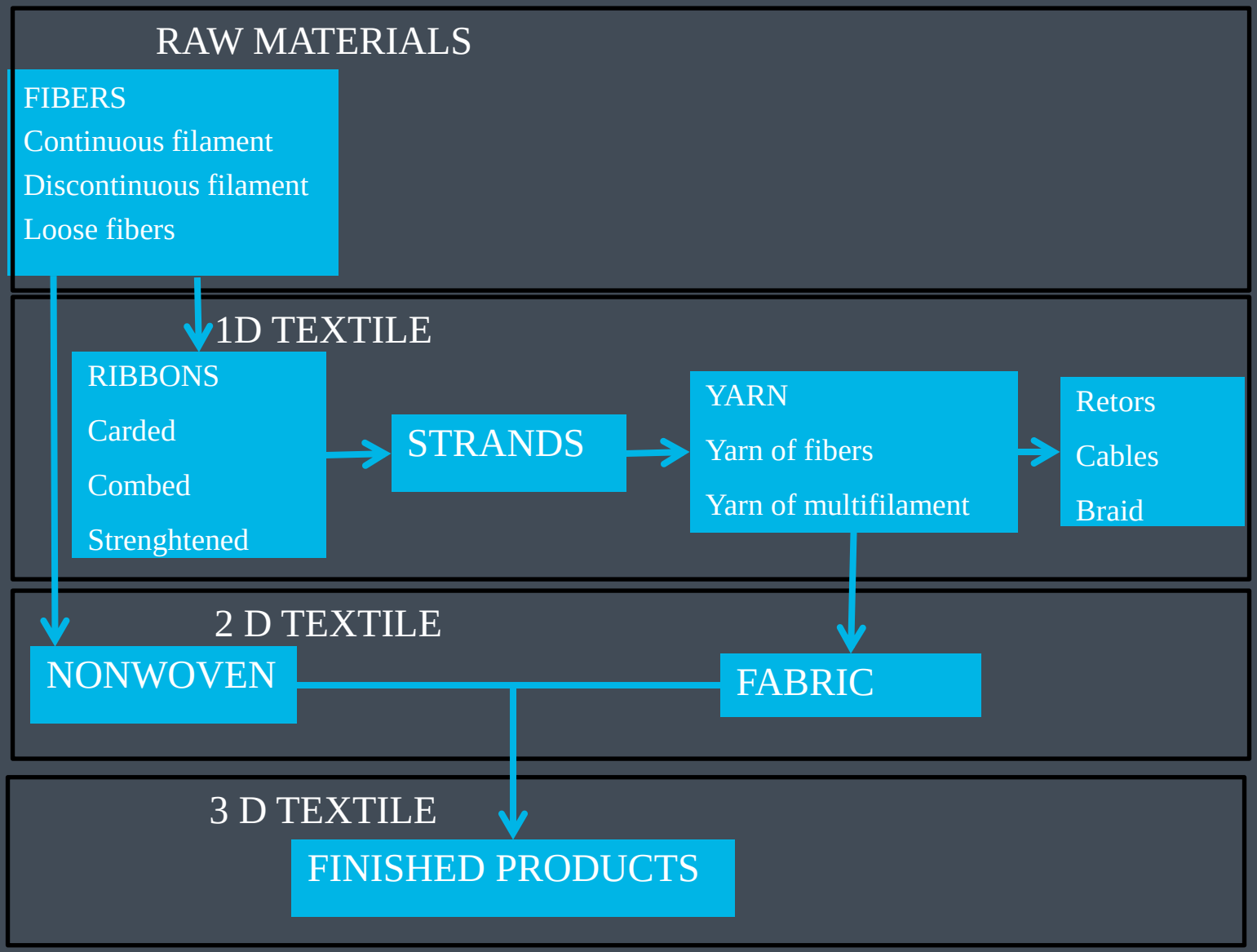
Maître de conférences ENSAIT

Objectives

- Basic Knowledge of textile
- What textile/polymer technologies are used in Photonitex ?
- What did Gemtex do in the past ?

I. Basic Knowledge

- Fiber characterization
- Yarn characterization
- Fabric characterization


RAW MATERIALS
FIBERS
Continuous filament
Discontinuous filament
Loose fibers
1D TEXTILE
RIBBONS
Carded
Combed
Strenghtened
STRANDS
YARN
Yarn of fibers
Yarn of multifilament
Retors
Cables
Braid
2 D TEXTILE
NONWOVEN
FABRIC
3 D TEXTILE
FINISHED PRODUCTS

Vocabulary

- ***Fibre discontinue*** *(Fiber)* *:* textile fibers generally of short length presented in flock

- ***Filament*** *(Filament)* *:*
- Textile fiber of « infinite » length

- ***Câble*** *(Câble pour fibres discontinues)* *(Tow)* *:* composite of a great numbers of filaments without important torsion build to construct discontinuous fibers.

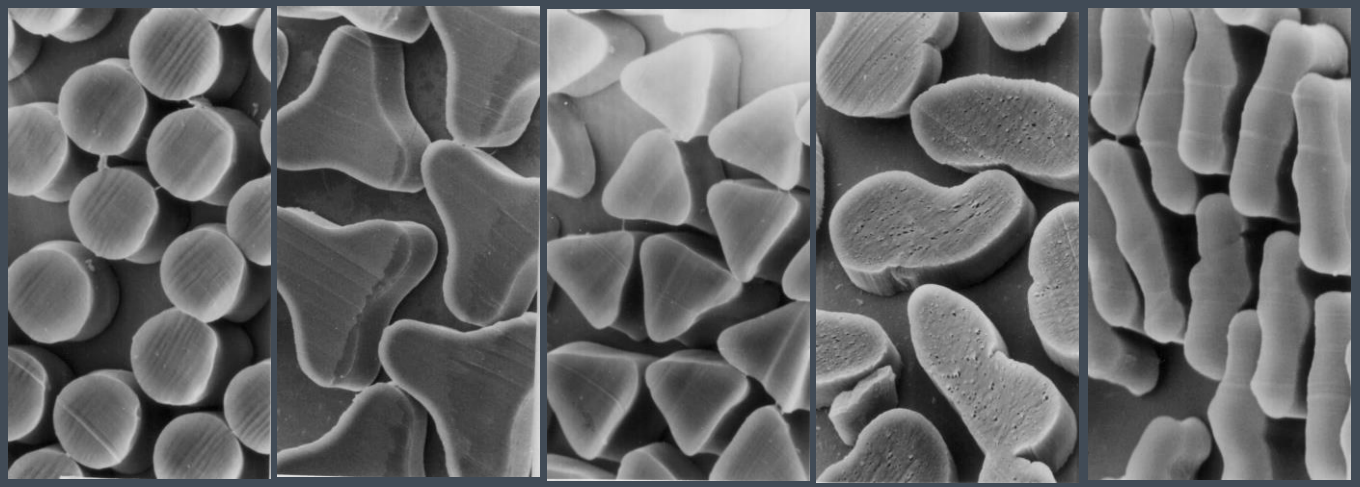
Fibers length

- Short fibers: cotton (20 mm)
- Long fibers wool (can go up to 200 mm)

- This is vital for the yarning process.

Fibers characterization

- Fiber identification
  - Microscope



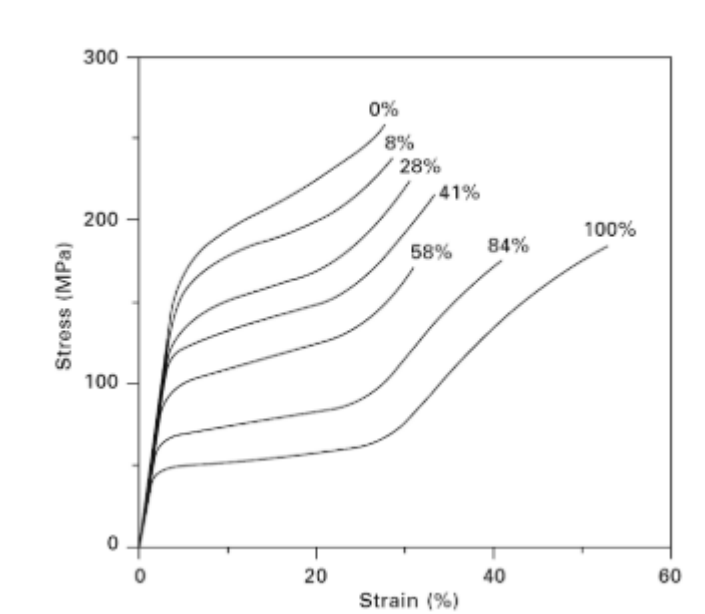
Fiber fineness/count

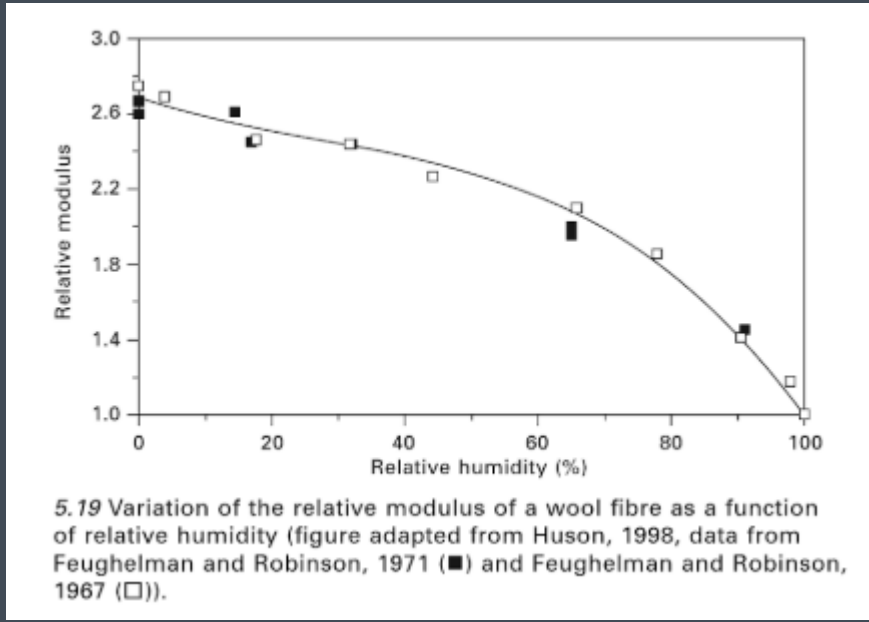
- $Count[Tex] = \frac{mass[g]}{length[km]}$ Yarn fineness

Standard unit example 25 Tex=a yarn of 25 g for 1 km (also 250 dtex)

	Number metric	**Denier**	**Cotton count**
Unit	Nm	Den	Ne.c
definition	$\frac{length\ [m]}{mass\ [g]}$	$\frac{mass[g]}{length\ [9\ km]}$	$\frac{length\ [840\ yards]}{mass\ [pound]} \sim \frac{[770m\ ]}{[0{,}45\ kg]}$
Value	1000/Tex	9 Tex	590.5/ Tex

Influence of RH on wool



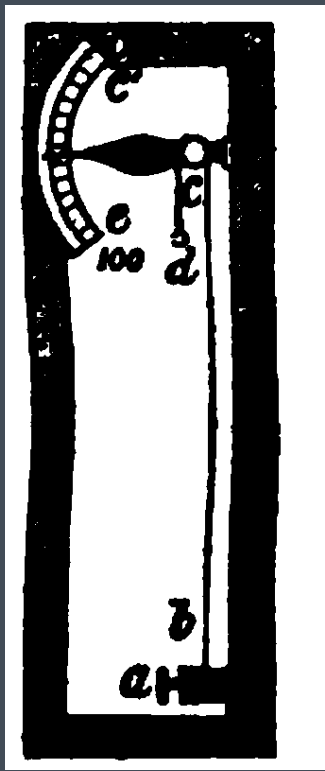


5.19 Variation of the relative modulus of a wool fibre as a function of relative humidity (figure adapted from Huson, 1998, data from Feughelman and Robinson, 1971 (■) and Feughelman and Robinson, 1967 (□)).

Handbook of tensile properties of textiles and technical fibers, p122

Different ways to measure RH

- Hair Hygrometer
  - «It consists of a human hair eight to ten inches long, b c, fastened at one extremity to a screw, a, and at the other passing over a pulley, c, being strained tight by a silk thread and weight, d.»
    - Natural fibers are so humidity dependent that it is used as a hygrometer



Draper, J.W., A Textbook on Chemistry1861: Harper & Brothers. P55/441.

Yarn characterization

- Yarn breacking strength
- Yarn pilosity
- Yarn torsion

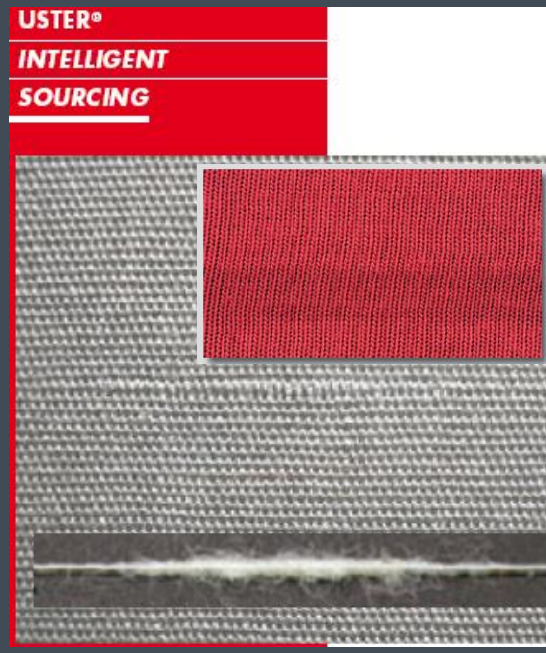
Vocabulary

- ***Fil*** *(Yarn) :* It is an assembly of essential length and relatively small cross-section of fibers and or / filaments with or without twist
- ***Fil monofilamentaire*** *(Monofilament yarn):* Yarn composed of a single filament
- ***Fil multifilamentaire*** *(Multifilament yarn):* Yarn composed of several filament
- ***Filé de fibres*** *(Spun Yarn):* Yarn composed of fibers

Yarn breacking strength

- Like with fibers the tenacity is defined

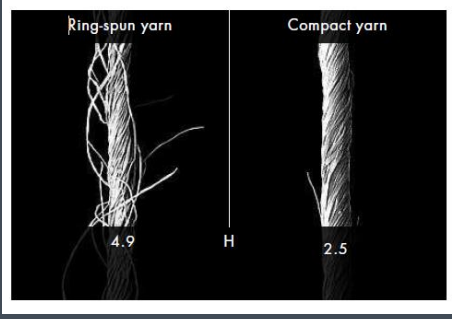
$$\tau[N/Tex] = \frac{breacking\ load}{count}$$



- Regularity
- Of the yarn regularity depends the default of the final fabric
- Regularity must be achieved in all steps of the fabrication: ribbons, strands, yarn

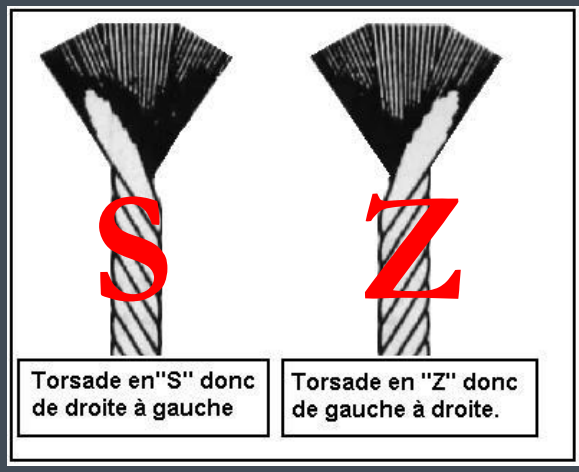
Yarn pilosity

- The yarn pilosity is expressed with H. H is the number of fiber cm outside the Yarn for 1 cm of Yarn.
- A high pilosity is good for some knitting process where a soft touch is wanted and generally bad for weaving.
- A low pilosity is good for weaving and avoid entanglement



https://www.uster.com/fileadmin/customer/Instruments/Yarn_Testing/Uster_Tester_5_broschure.pdf

Yarn torsion



- The torsion of a yarn is defined by the number of turn per meter and by the orientation
- The torsion is a key parameter of a yarn mechanical resistance with the fiber nature and the yarn fineness.
- In order to have a loose coton tee shirt a low torsion is recommended whereas to obtain a harder yarn with the same cotton a high torsion is required

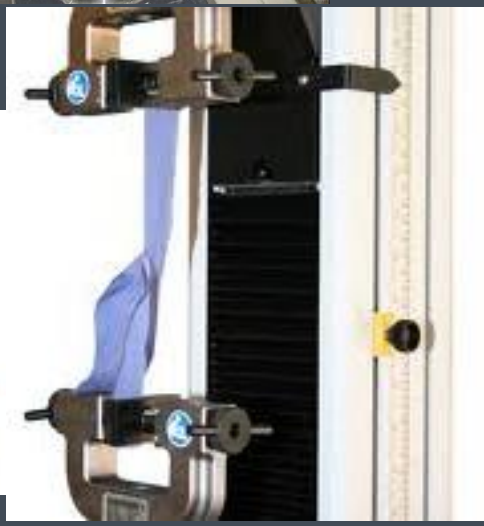
Fabric characterization

- Fabric mechanical test
- Fabric stitching resistance
- Fabric abrasion
- Air and water permeability

Fabric: mechanical tests

- Tensile test
  - In both weaving direction
  - In both knitting direction

- Tearing test
  - Measurement of the resistance of a fabric bebore tearing.



Fabric stitching resistance

- The objective is to measure the stitching resistance by pulling two independant fabric apart.
- It is then possible to choose between different sort of stitching
- Applications clothing, furniture, …

Fabric: abrasion

- A circular sample is submitted to abrasion against an abrasive

fabric	**Deterioration point**
weaving	2 different Yarn breacking
knitting	Breacking of a yarn with apparition of a hole
velvet	Complete wear of the velvet
Nonwoven	First hole bigger than 0,5mm in diameter

- Applications clothing, furniture, …

Fabric: permeability air and water

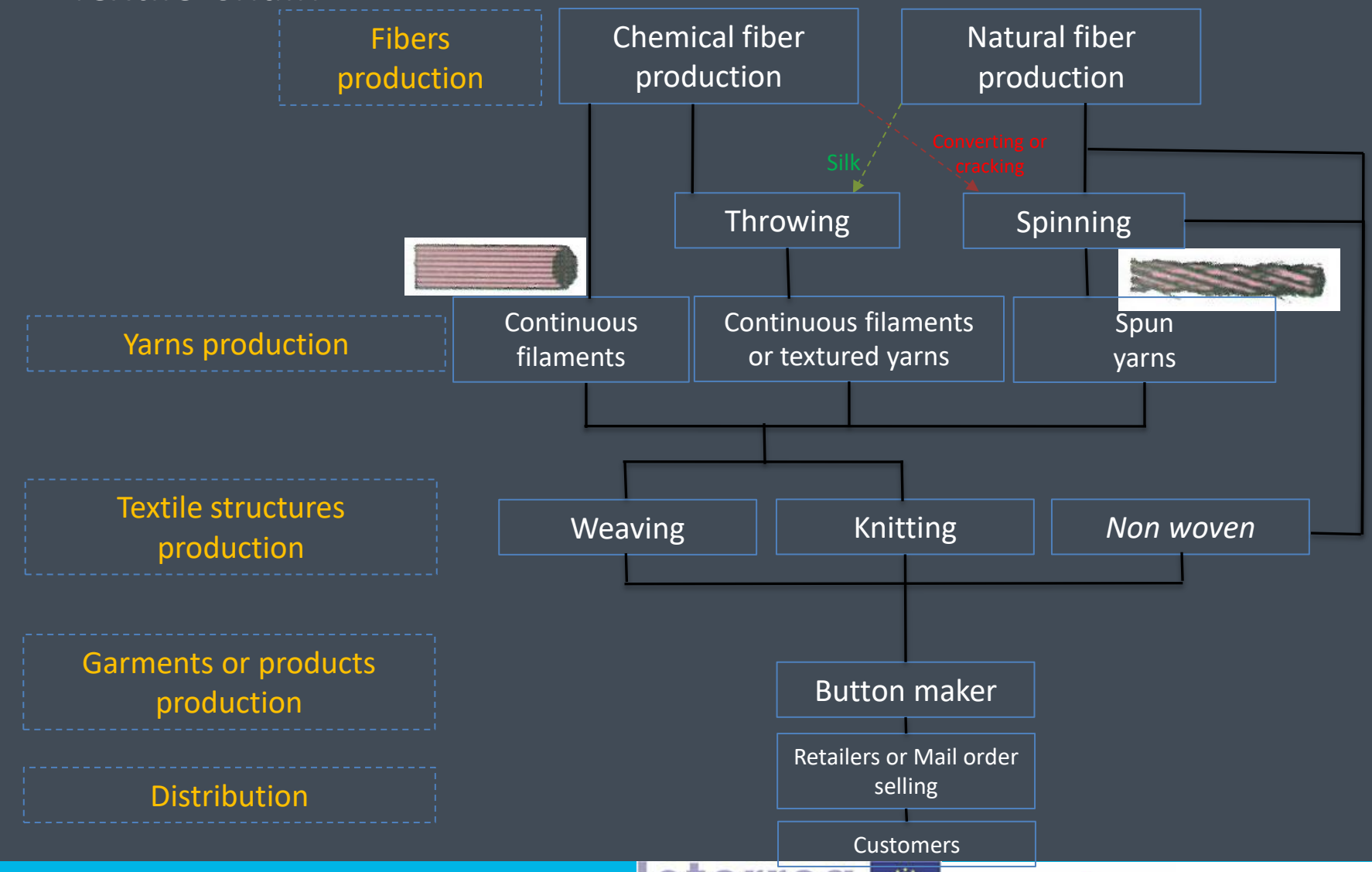
- Air permeability of a fabric is the possibility for this fabric to be crossed by air. It is given in l/m²/h for a given pressure.
  - Applications: wind stopper …
- Water penetration of a fabric is the pression at which 3 drop of water will appear on the opposite surface.
  - Applications k-ways,

II. What textile/polymer technics are used in photonitex

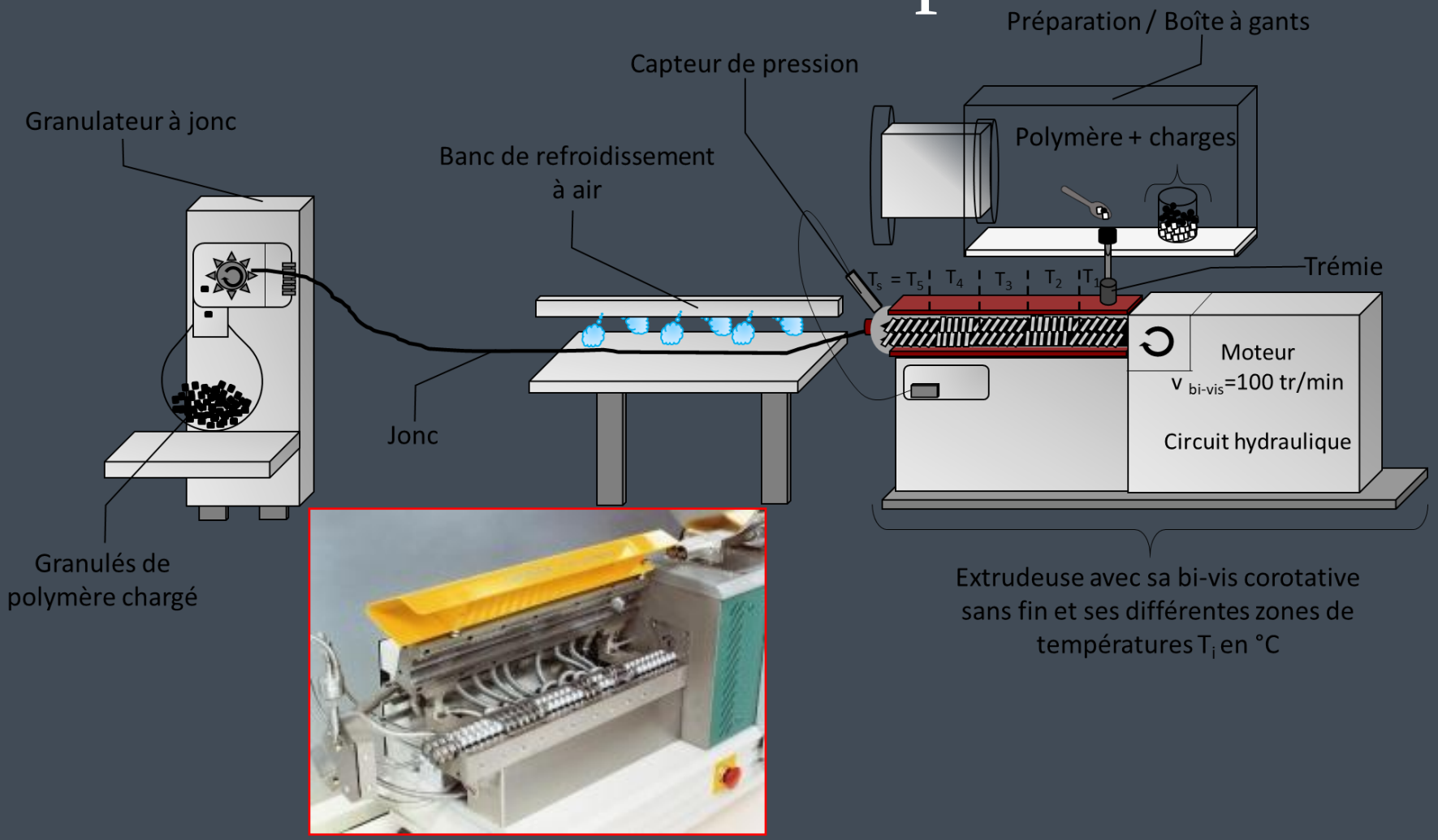
- Textile chain
- 2 screws extrusion process
- Synthetic fiber spinning

Traditional textile

Textile Chain



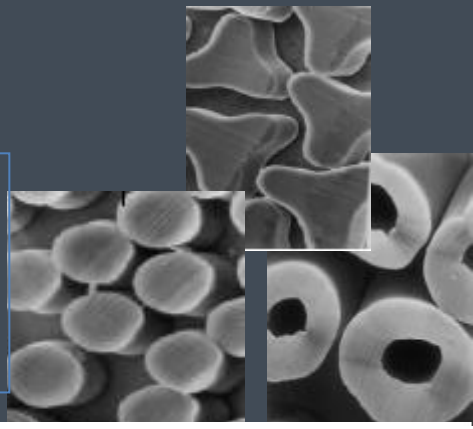
2 screws extrusion process

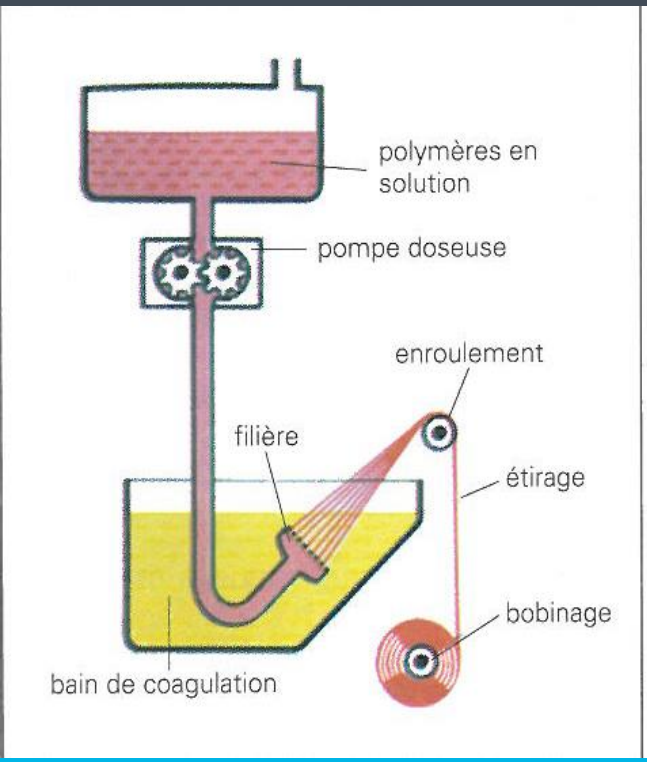


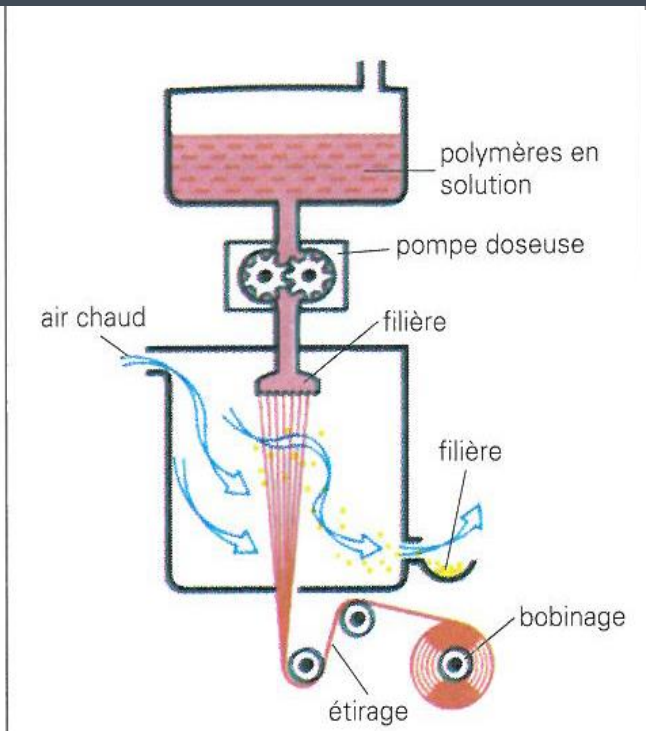
Chemical fibers spinning

-**Voie solvant** (Solvent):
- **Humide** (Wet) : Viscose, Acrylic,…
- **Sec** (Dry) : Acetate, Triacetate, Chlorofibre, Acrylic, Elastofibre,...

- **Voie fondue** (Melt) : Polyethylene, Polypropylene, Polyamide, Polyester,..



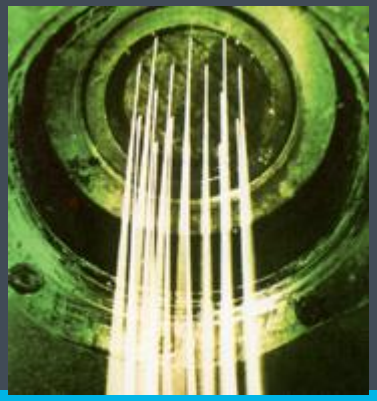


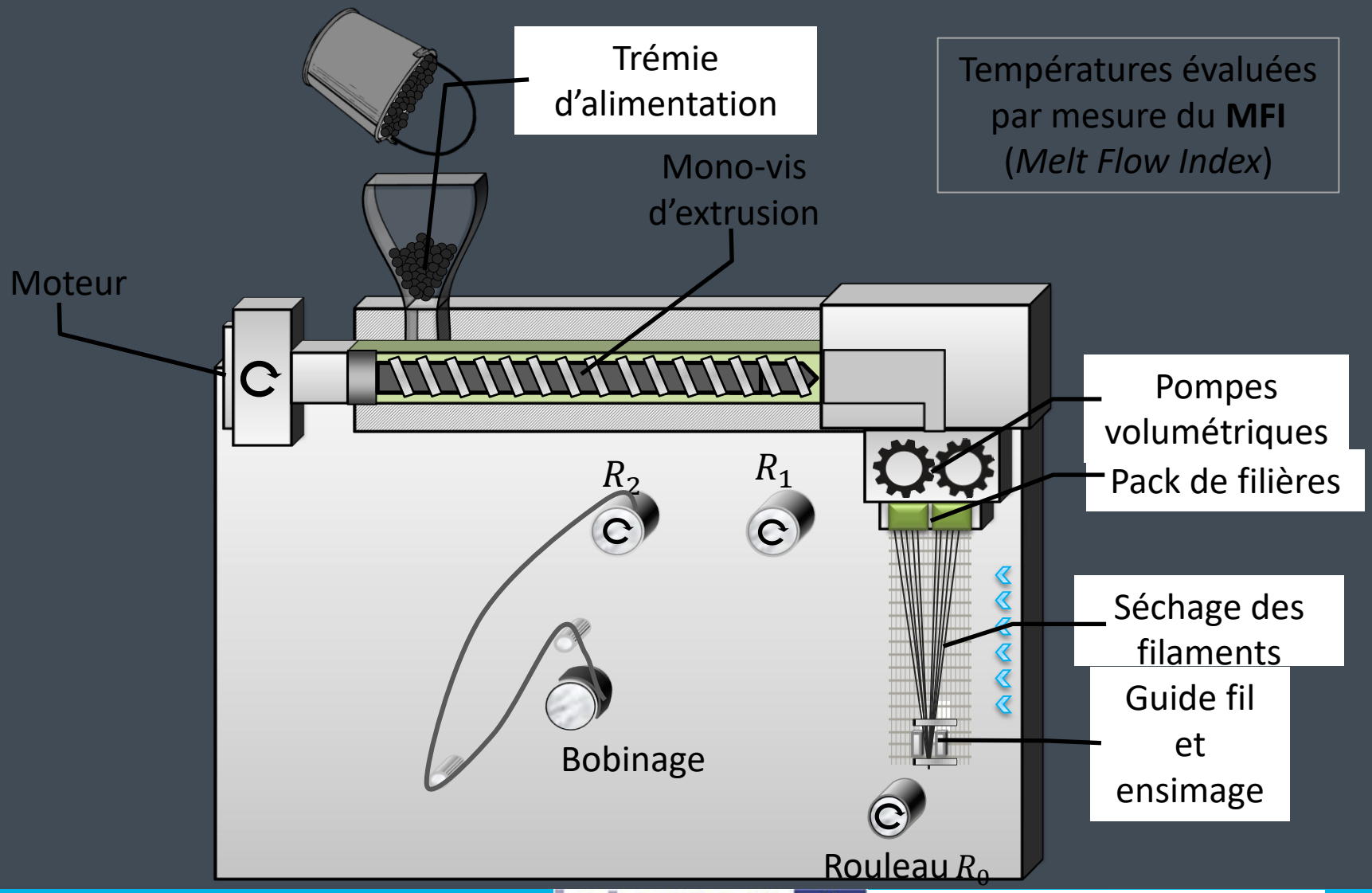


Filage par voie fondue/melt spinning

Principle of spinning of chemical fibers from melted polymers or diluted polymer

Polymer → filaments going trough nozzles
Filaments → extended thanks to rollers changing physical and mechanical properties

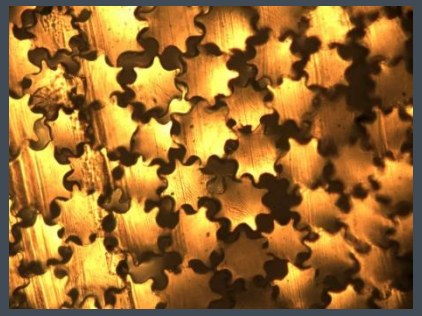


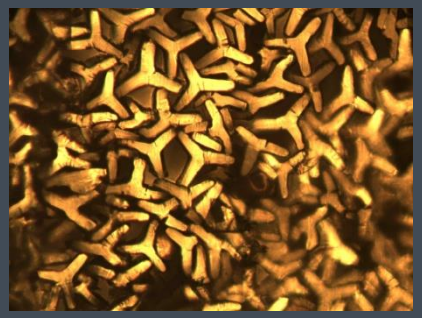

Trémie d'alimentation
Mono-vis d'extrusion
Moteur
Températures évaluées par mesure du **MFI** (*Melt Flow Index*)
Pompes volumétriques
Pack de filières
R_2
R_1
Séchage des filaments
Guide fil et ensimage
Bobinage
Rouleau R_0

Melt spinning in video

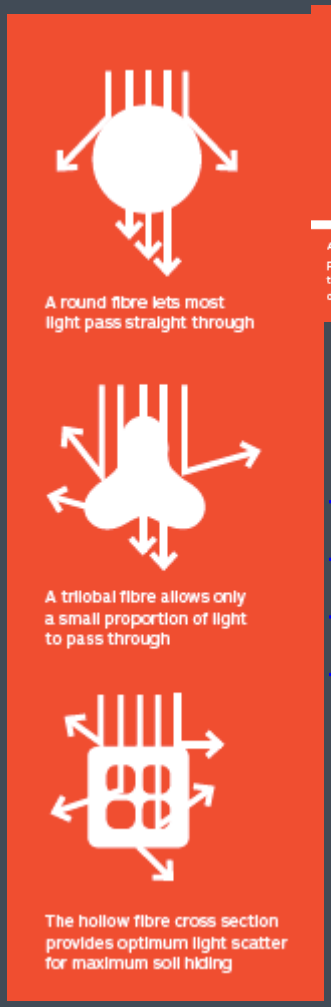
Melt spinning nozzle:

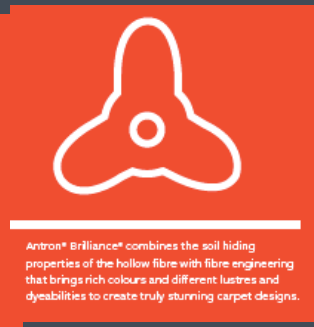
Nozzle shapes





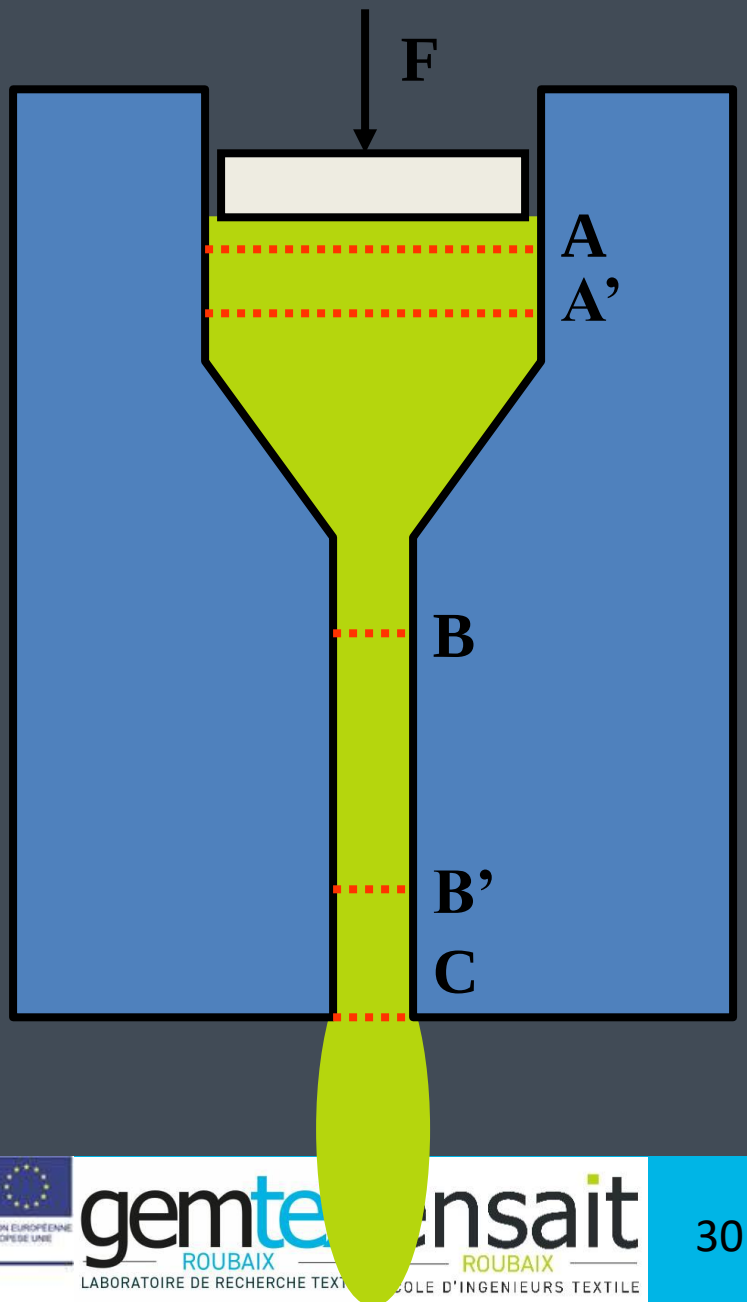
- Ø=30-70µm





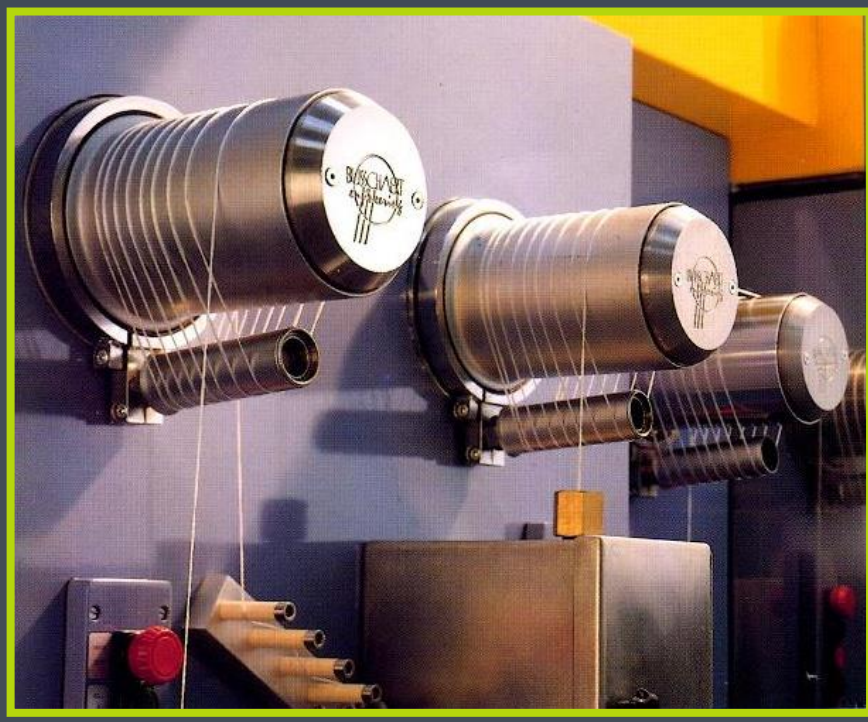
http://www.antron.eu/fr/literature.html

- A →B: lateral compression elongationnal stress
- C : macromolecule have a tendancy to relax and expand
- Barus effect



Melt spinning interest

- Conversion from an isotropic polymer to a strongly anisotropic polymer
- Polymer orientation parallel to the filament direction



Count approximation

- Depending on yarning process parameter

$$\text{Titre (dtex)} \cong \frac{V_p \times d \times T_p}{V_{r_2}} \times 10\,000$$

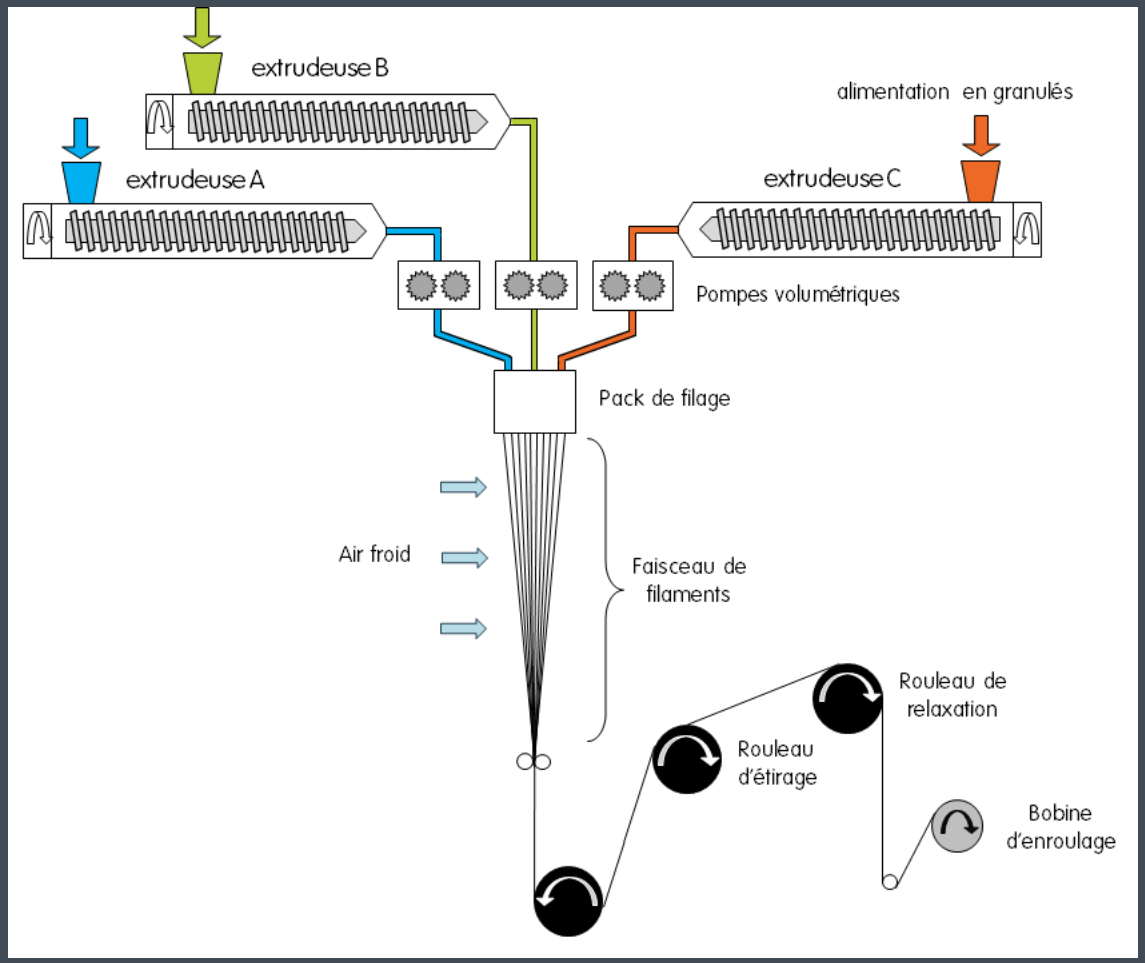
V_p = volumetric pump

d = relativ density of melted polymer

T_p = Number of turns of the volumetric pump

V_{r2} = speed of the last roll

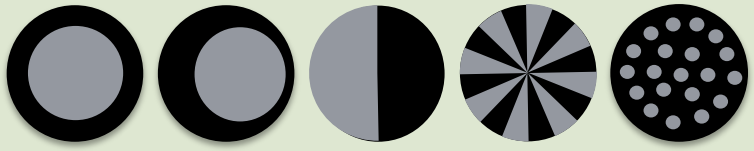
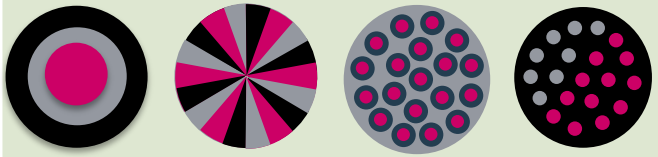
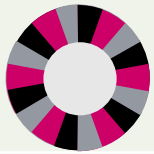
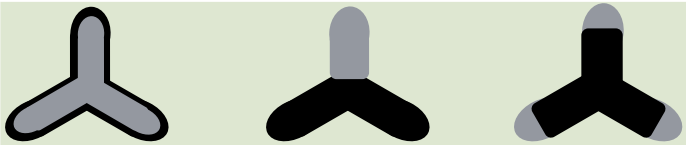
Multicomponents spinning



CETI
CENTRE EUROPÉEN DES TEXTILES INNOVANTS

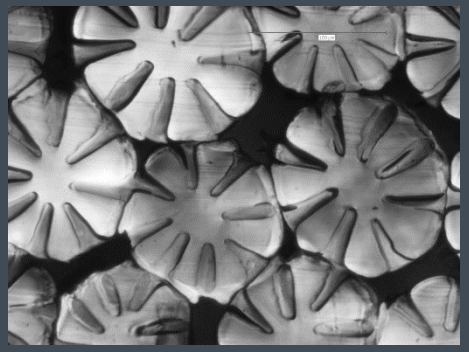
Interreg France-Wallonie-Vlaanderen
PHOTOTEX
gemtex ROUBAIX LABORATOIRE DE RECHERCHE TEXTILE
ensait ROUBAIX ECOLE D'INGENIEURS TEXTILE

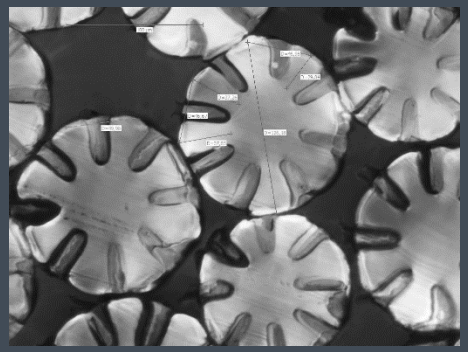
Multicomponents spinning

	BICO	TRICO
Round		
Hollow		
Trilobal		

Multicomponents melt spinning

deformation





« flower »

⇒2materials one filled the other not …

⇒Irregular repartition in one of the polymers

⇒2 materials with totaly different mechanical behavior

CETI CENTRE EUROPÉEN DES TEXTILES INNOVANTS

2 interesting project the GEMTEX worked on

- Project IMS&CPS
- Projet Filairco

Projet IMS&CPS (2010-2013)

Innovative Material Synergies & Composite Processing Strategies

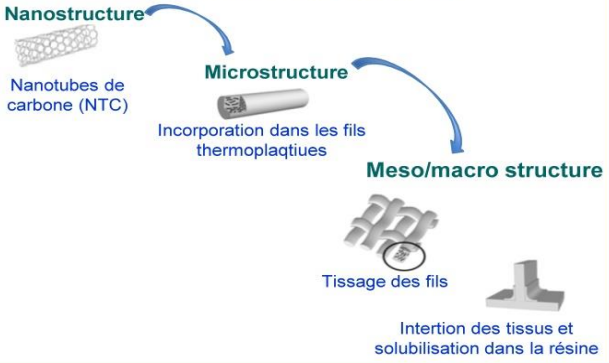
Projet Européen, 7ème PCRD
Thèse : *Jonas Bouchard*

16 partenaires :
(7 laboratoires universitaires, 2 centres de recherche et 7 industriels)
Coordinateur:
Coexpair (BE)

Objectif du projet

Renforcement des **propriétés mécaniques des composites** (propriétés d'impact et interlaminaires)

Dissipation des charges électriques (protection contre la foudre et les interférences magnétiques).

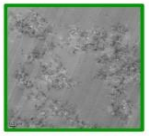


Tâches GEMTEX

Elaboration par filage en **voie fondue** et **voie solvant** de filaments conducteurs **thermostables** chargés en NTC.

Orientation et **alignement** des NTC dans le sens de la fibre, optimisation des propriétés mécaniques et électriques du fil.

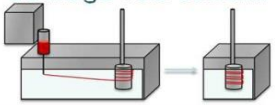
Formulation de nanocomposites polymères conducteurs thermostables



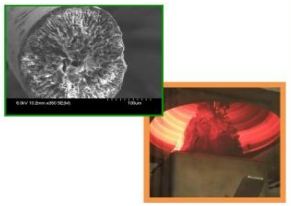
POLYETHERSULFONE,
Nanotubes de carbone
Plastifiants

Adaptation du procédé filage voie fondu

Mise en place d'un dispositif laboratoire de filage voie solvant



Amélioration des propriétés électriques et du comportement au feu



Personnels impliqués

3 publications avec comités de lecture
7 communications orales et affiches

gemtex ROUBAIX LABORATOIRE DE RECHERCHE TEXTILE

Projet FILAIRCO (2012-2016)

FILage multi**CO**mposant pour le développement de matériaux fibreux innovants et fonctionnels - Applications à la filtration de l'**AIR**

filairco

14ème FUI

Thèse CIFRE : *Esma Ayad*

CETI PRODUCT INSIGHT DESIGN YOUR TEXTILE SOLUTIONS

11 partenaires :
(2 laboratoires universitaires, 1 centre de recherche et 8 industriels)
Coordinateur: **Honeywell**

LRGP LABORATOIRE RÉACTIONS ET GÉNIE — MECAPLAST FRANCE — mortelecque — RBC — ARKEMA — PYLOTE — CARPENTIER & PREUX — Libeltex Smart Nonwoven Solutions

Objectif du projet

Mettre au point de **nouvelles fibres multicomposantes** pour l'obtention de matériaux fibreux innovants et fonctionnels pour la filtration de l'air

Valider la mise en œuvre des nouvelles fibres par des **procédés nontissés** et tissés

Filtres Automobiles | **Masques Respiratoires** | **Filtres Industriels**

Amélioration des propriétés de filtration :
Augmentation efficacité
Diminution perte de charge

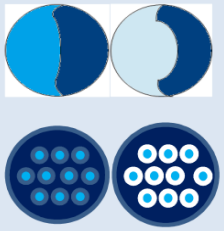
Tâches GEMTEX

Obtention des fibres **ultrafines** par filage **multicomposant** en voie fondue

AVANT séparation des composants ~**20** µm

APRES séparation des composants < **2**µm

Forme et qualité de l'interface : Identification des propriétés intrinsèques des polymères

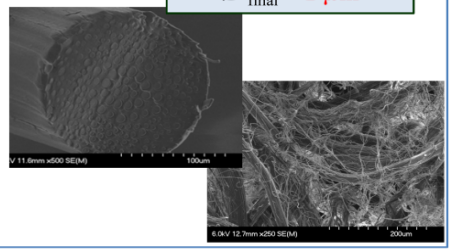


Influence du **rapport de viscosités** à prendre en compte sur une **large fenêtre du taux de cisaillement**

Influence du **placement des matériaux** dans la morphologie en fonction de la **température de cristallisation**

Obtention de voiles nontissés (voie sèche) à forte surface spécifique

300 îles-en-mer
Ø final ~ **1 µm**



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