Textile structures as template for structured ceramics : fibers, fabrics & production processes

Specific polymer spinning
Textile structures production

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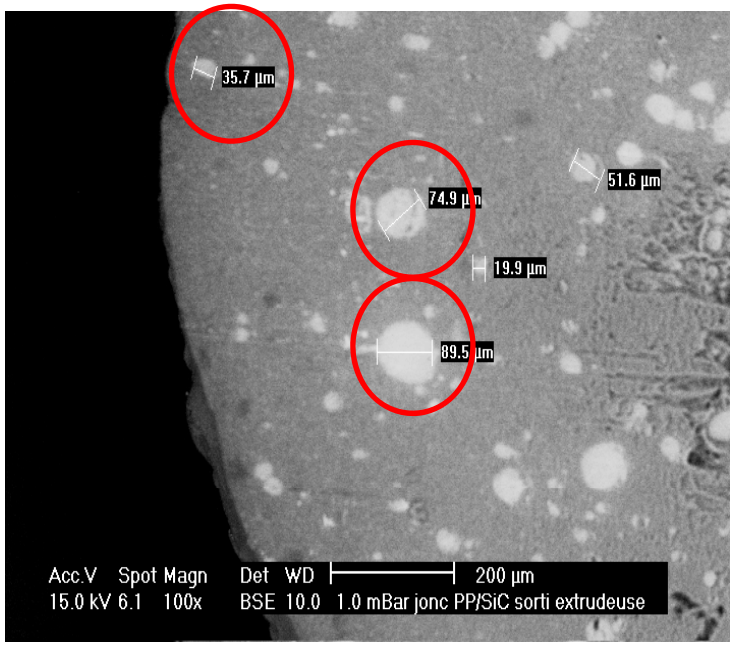
Development work on templates based on textile structures

- Compounding of new material with PP and SiC suitable for spinning
- Spinning trials with new materials suitable for later ceramization
- Shaping of heat exchanger geometries with textile machines

Polymer spinning : Main results

Compounding trials

- Melt compounding of PP / SiC 50/50, 75/25, 90/10

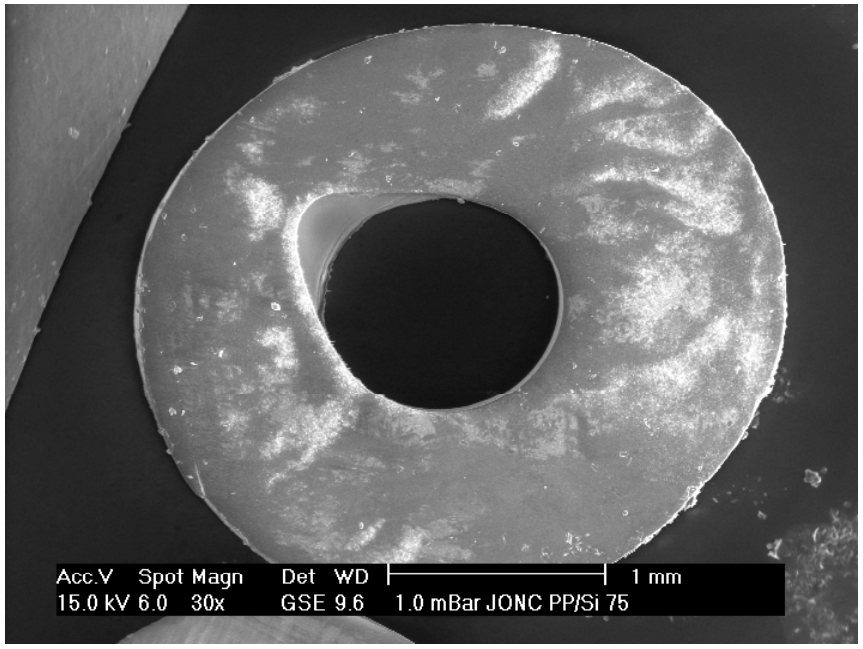


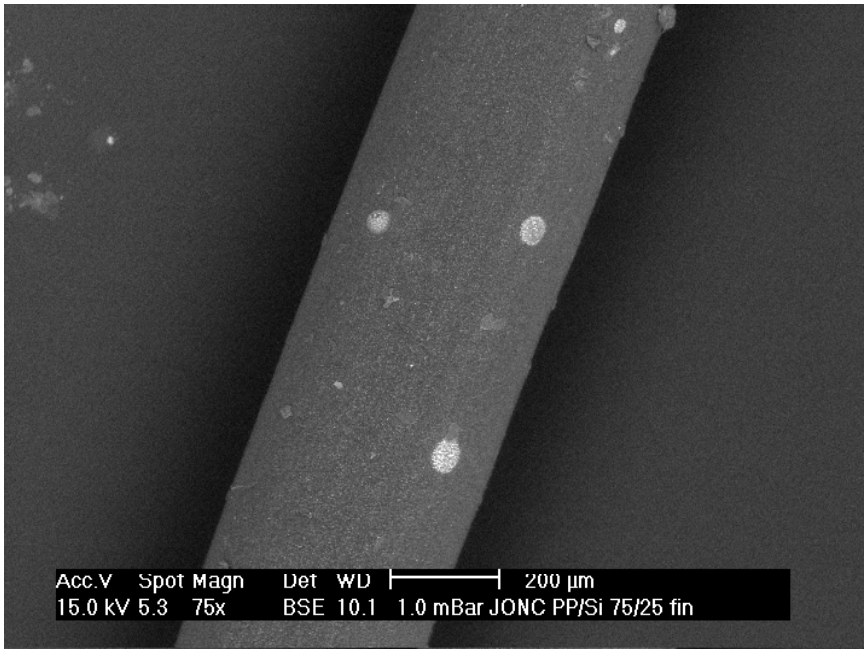
- Presence of SiC agglomerates

- TGA → dosing OK but local heterogeneity

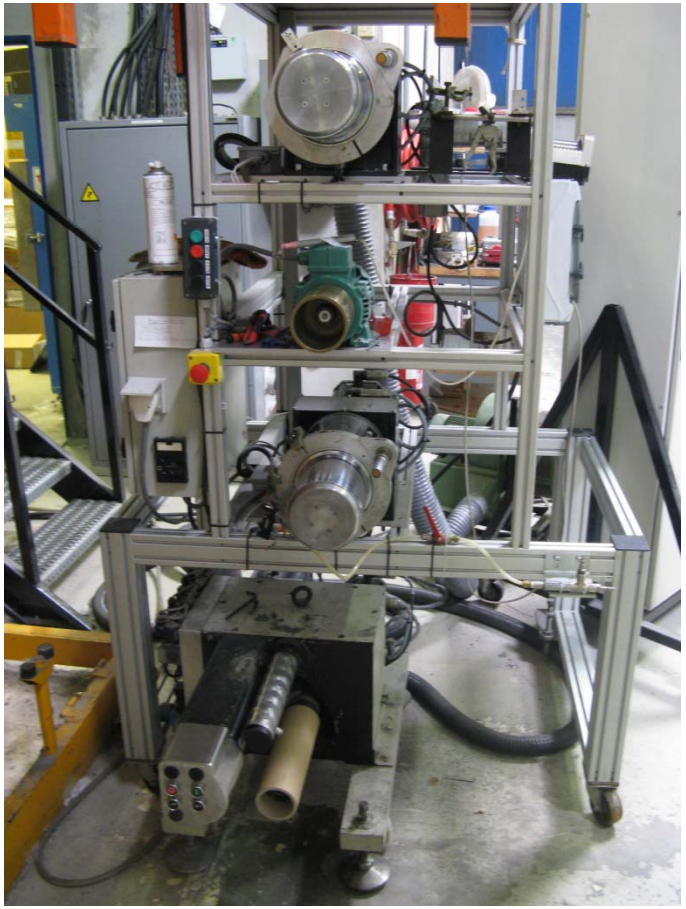
Main results: Compounding trials

✓ ESEM Micrographies of *PP/SiC 75/25*





Melt spinning: laboratory pilot



Melt spinning: industrial pilot

Multifilament yarn melt spinning machine

- 2 single-screws (5 and10 kg/h) L/D = 30 for bicomponent system
- Maximum temperature: 450 °C
- 1 to 10 kg/h
- Winding from 1000 to 4200 m/min

Polymer spinning: conclusion

- Ceramization trials have shown that 10% of SiC were not enough to avoid a final hollow structure.
- Spinning process has shown difficulties to spin over 10% SiC, because of blocking of spinneret holes
- Pure PES yarn has a quite good behaviour to ceramization process (more C in the molecular structure)

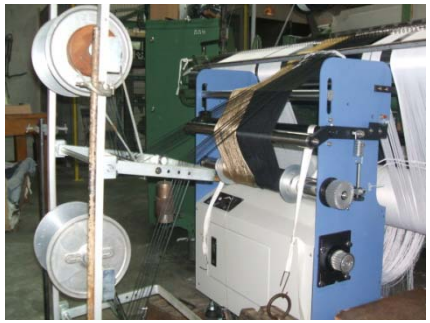
➔ Therefore, we have chosen a multifilaments PES yarn for the last textiles structures

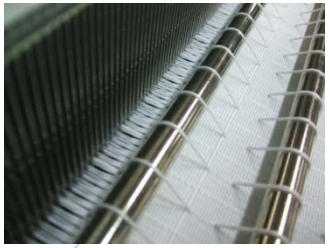
Polymer structures : Review of first works: monofilament

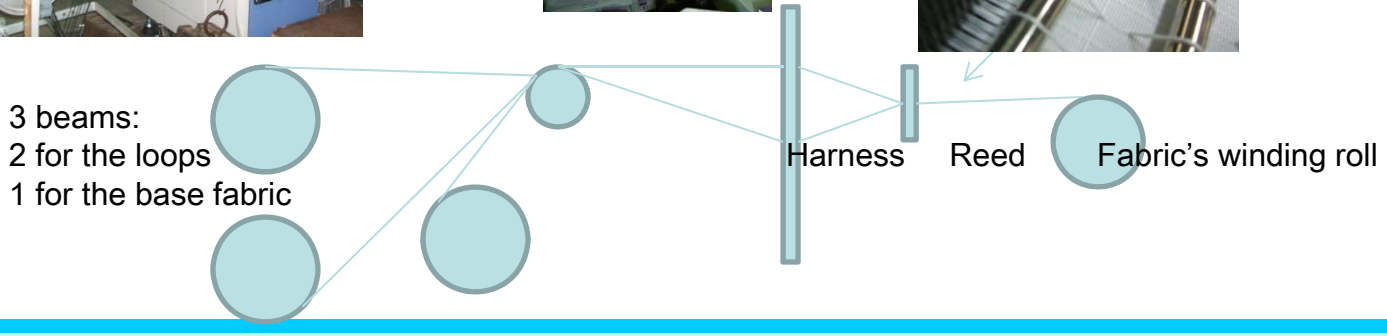
Trial	
Knitting	Impossible to knit monofilament on our looms To go further with sub-contractor's machines
Braiding	No known machine to make a double skin braid
Trimmings 	Should be an interesting trial if coupled with filament winding technology
Grids 	No convenient machine found for such structure
Weaving 	Possible on different types of looms

Textile structures: weaving

- Definition of the fabric ‘s drawing regarding the simulation data from TU BAF
- Adaptation of terry cloth’s process on one of our weaving looms



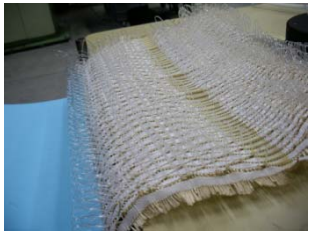




Textiles structures: weaving

Samples used for ceramization testing

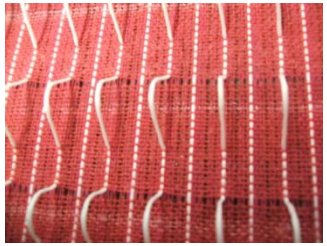
PP



25 cm * 45 cm
x 2

PET

25 cm * 90 cm
x 3



10cm * 10 cm
x 10
30 cm * 120 cm

PANox

25 cm * 90 cm
x 1

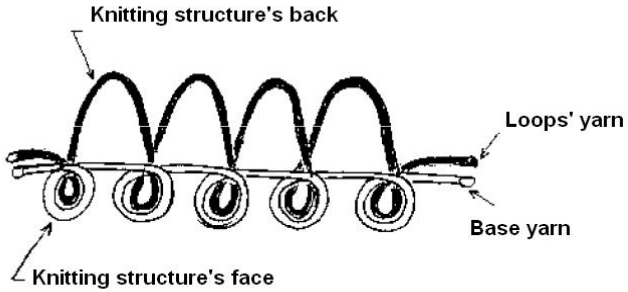
Textiles structures: knitting

Terry warp knitting machines

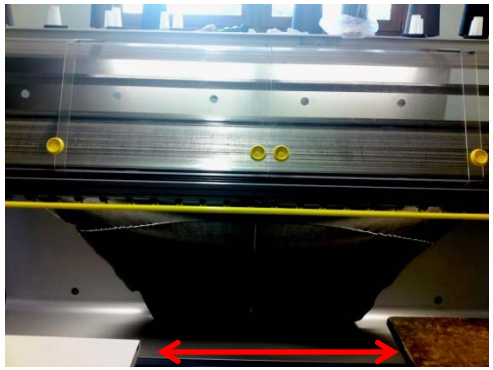
In particular cases and for small productions, with special design : flat weft machines.

Textiles structures: knitting

In general rules, it's relatively easy to obtain classic loops with knitting technologies



But be careful about capacity of elastic deformation and shrinkage in width.



Loops knitting technology: design

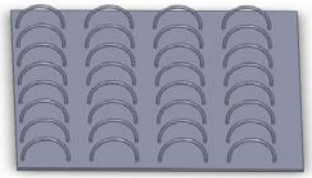
Definition of drawing regarding geometry

The various geometries of the loops require a specific knitting loom :
flat weft electronic machine (strickerei)

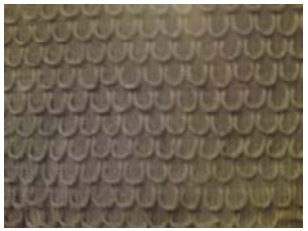
It allows to control:

- ✓ loops height
- ✓ space between loops
- ✓ Shape of the loops base

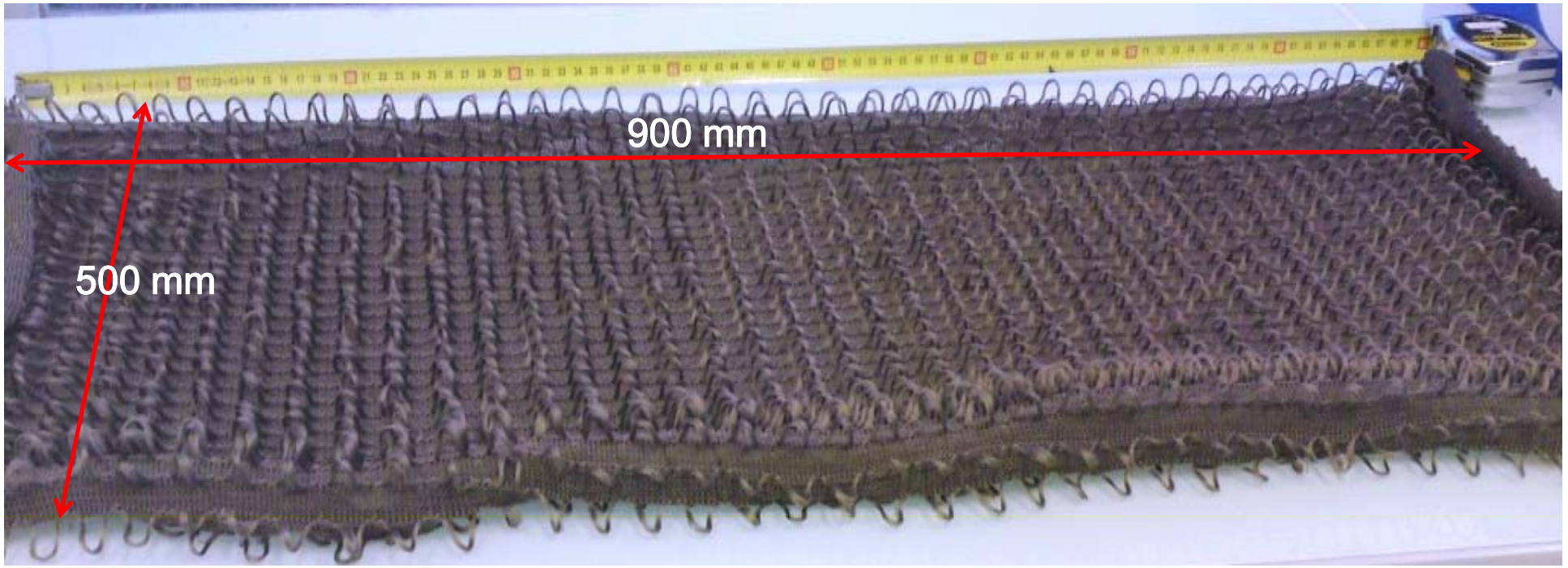
Geometry 1
Parallel arrangement with 3600 Loops/m²
Radius of the loops 8 mm (middle fiber)



Geometry 2
Staggered arrangement with 7000 Loops/m²
Radius of the loops 8 mm (middle fiber)



Details of suitable knitted fabrics



Textiles Structures : Conclusion

- Multifilament polyester yarns

- Loose base fabric with hydrosoluble yarn

- The last knitted fabrics seem appropriate for the ceramization process

- BUT, every change in geometry can cause noticeable modifications in knitting structures and therefore behaviour during ceramization

(for example: space between loops lines)

Thank you for attention !