

PRODUCTION AND CHARACTERIZATION OF SUPER-ABSORBENT AND HYDROPHOBIC MEMBRANES FOR TEXTILE ERGONOMICS IN ALPINE ENVIRONMENT

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INTRODUCTION

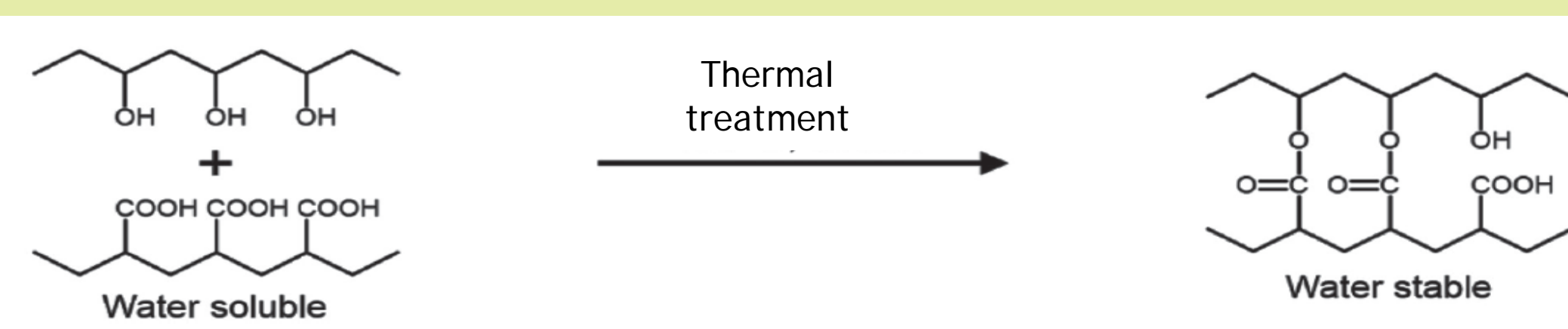
In many extreme climatic situations, breathable fabrics protect the human body from external heat, wind, water, and many harmful agents, and at the same time they also permits effective transmission of moist vapor from inside to outside atmosphere.

The present work shows the development of innovative waterproof breathable membranes based on super-absorbent and super-hydrophobic layers of different electrospun materials.

EXPERIMENTAL

SUPER ABSORBENT FIBERS

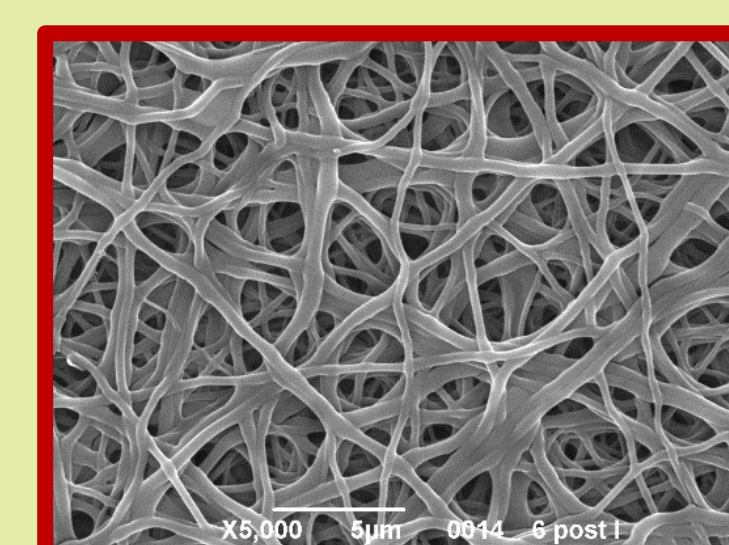
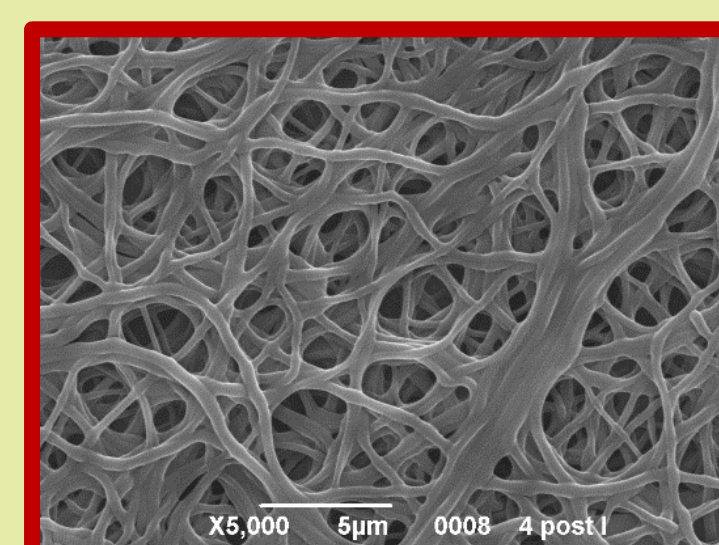
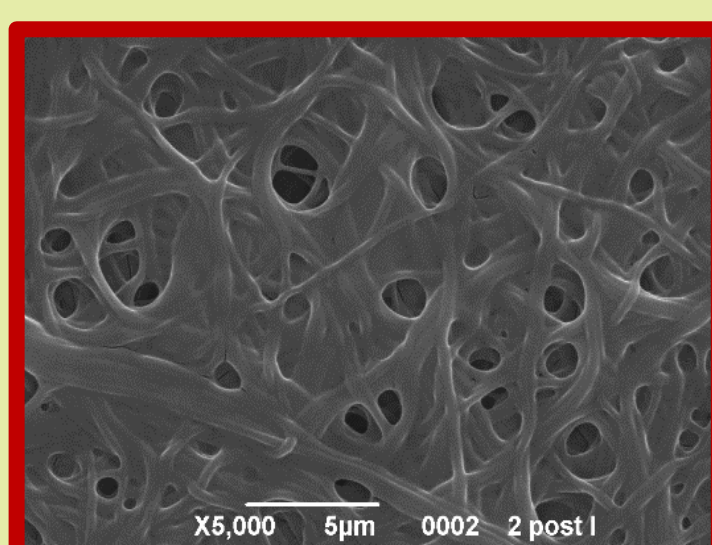
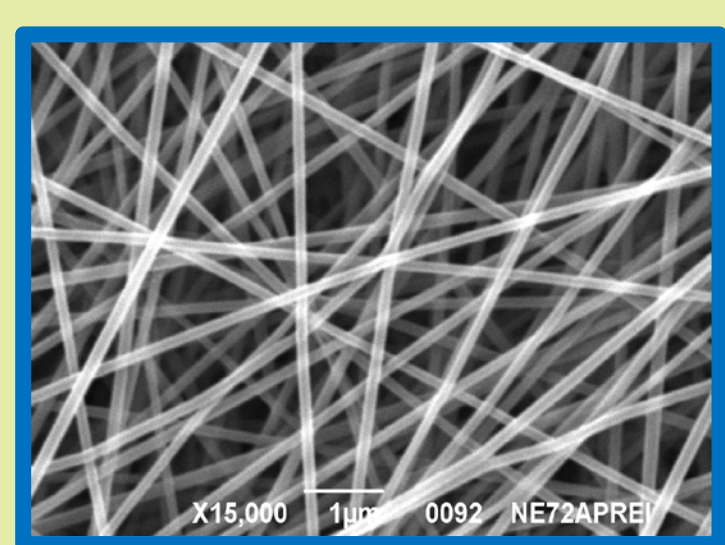
Polyacrylamide-co-acrylic acid (PAAM-co-AAc) + PVA



Electrospinning parameters & optimization:
PAAM-co-AAc/PVA = 75:25 w/w, 16% water solution
Distance needle-collector = 20 cm;
Feed rate = 0.1 ml/h; Voltage = 20 kV

Electrospun crosslinked membrane BEFORE immersion

Electrospun crosslinked membrane POST immersion (6h immersion followed by drying)



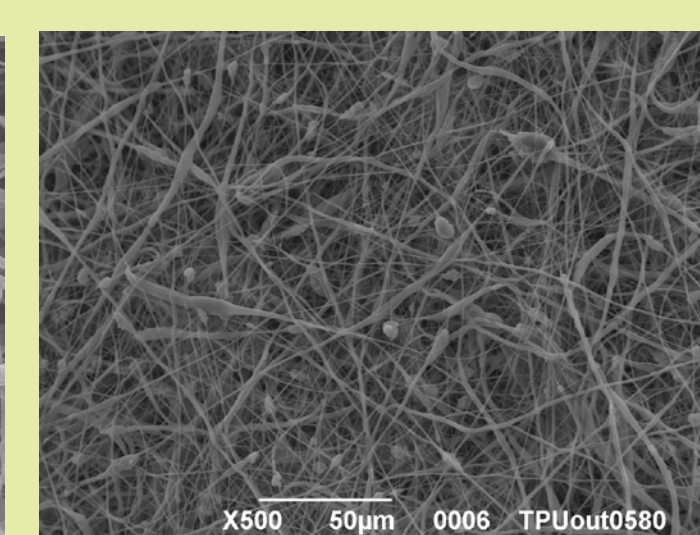
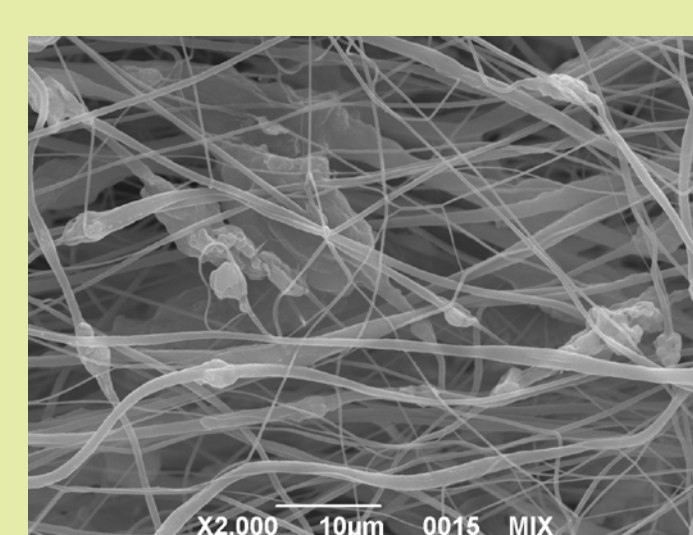
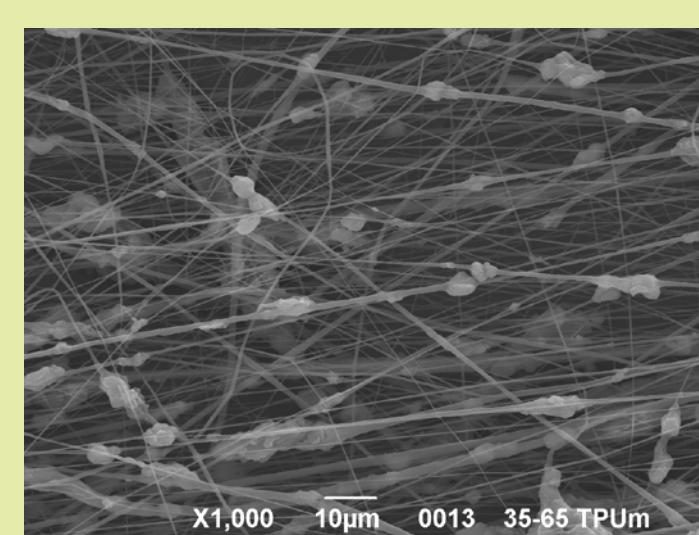
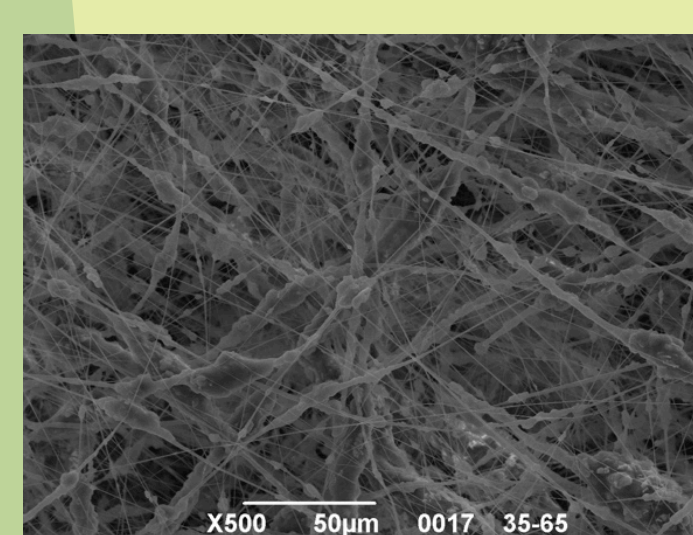
2h 160°C 4h 160°C 6h 160°C

EFFECT OF THERMAL-TREATMENT TIME

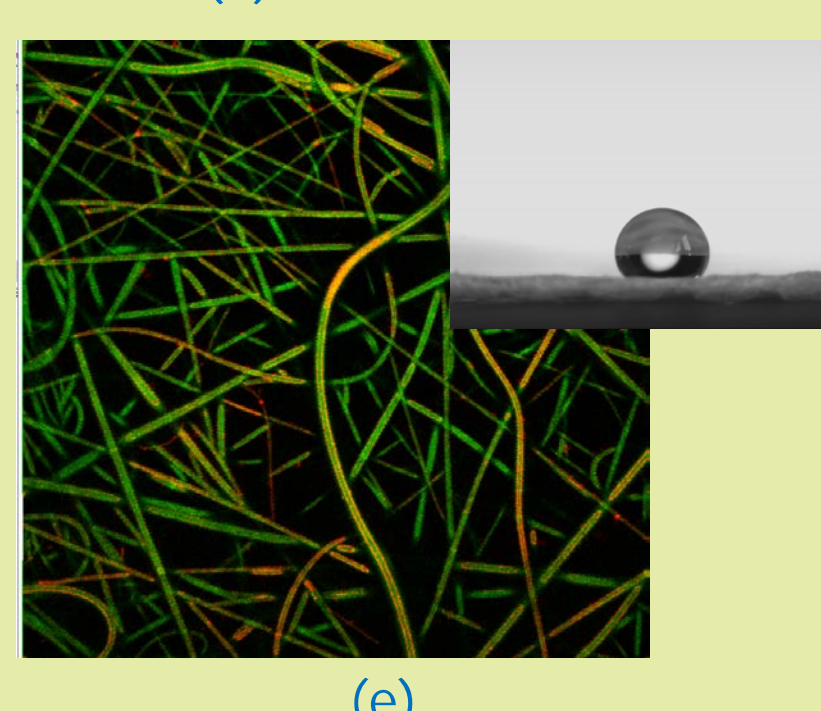
HYDROPHOBIC MEMBRANES

PVDF-PTFE-TPU

- PVDF:PTFE=35:65 membrane
- PVDF:PTFE=35:65 /TPU simultaneously electrospun
- PVDF:PTFE=35:65 /TPU mixed before electrospinning
- Coaxial electrospinning: (TPU shell-PVDF:PTFE core)



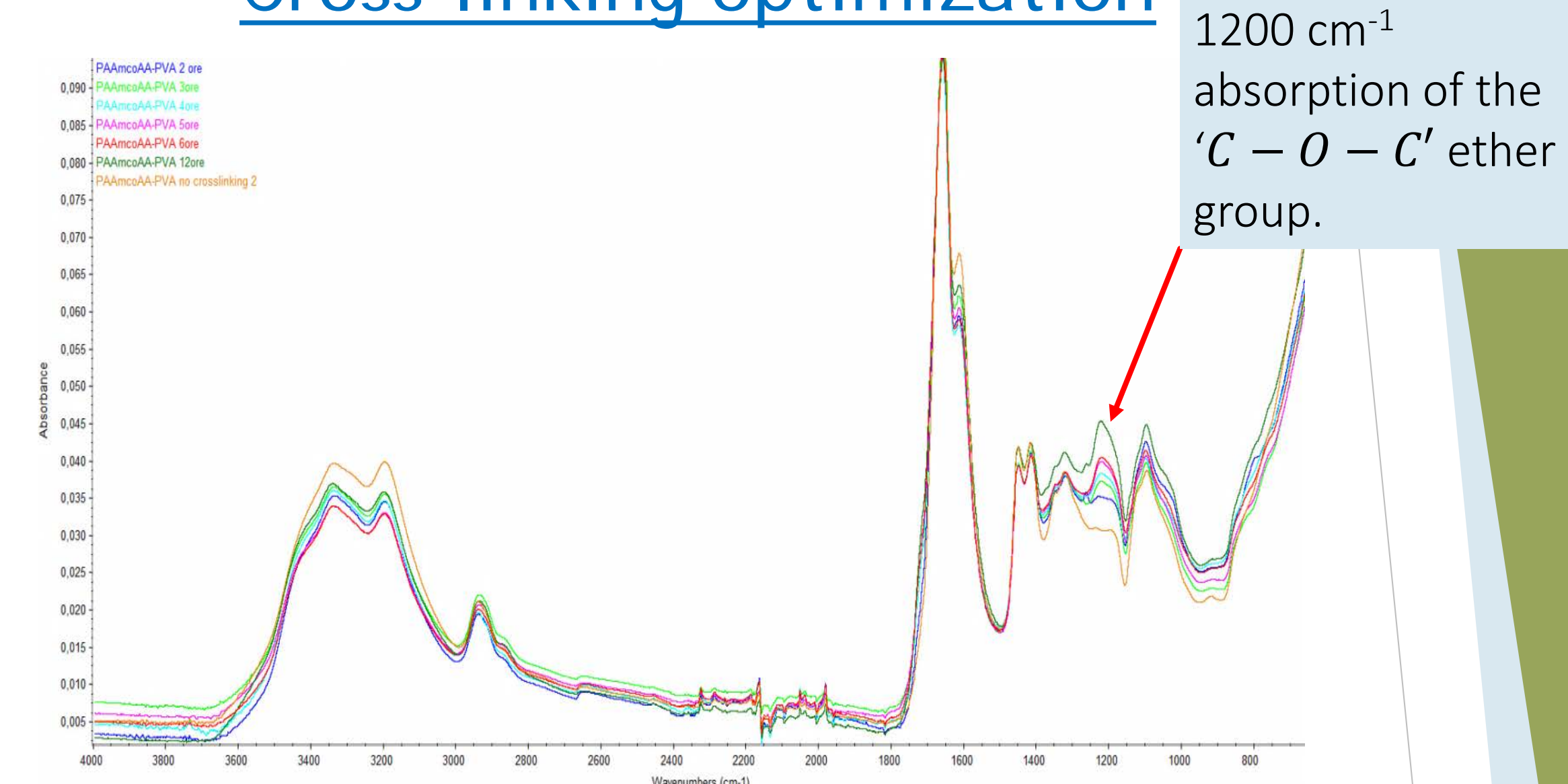
SEM micrographs: (a) PVDF/PTFE 35:65; (b) PVDF:PTFE=35:65 /TPU simultaneously electrospun; (c) PVDF:PTFE=35:65 /TPU mixed before electrospinning (d) Coaxial electrospinning: TPU shell-PVDF:PTFE core; (e) Confocal image of coaxial TPU (shell-green), PVDF/PTFE (core-red). Right corner: contact angle (θ) measurement: $\theta = 120.9 \pm 0.7$



RESULTS

1. Super absorbent membrane:

Cross-linking optimization

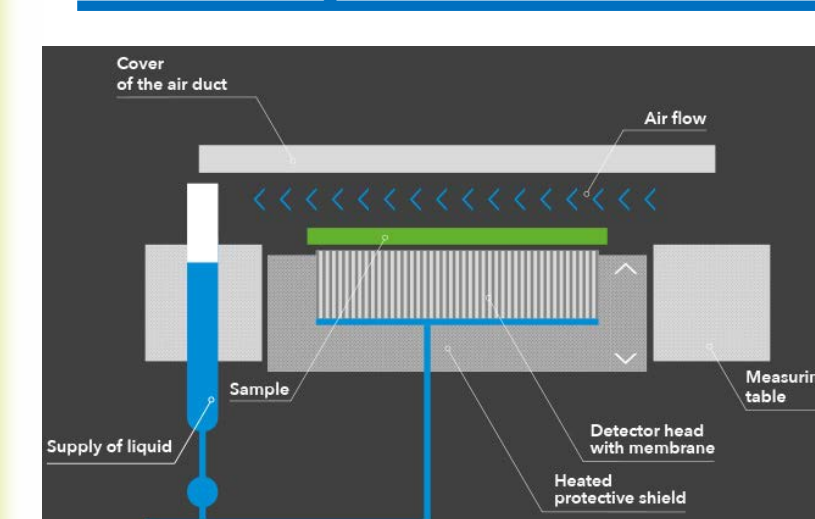


Swelling behaviour

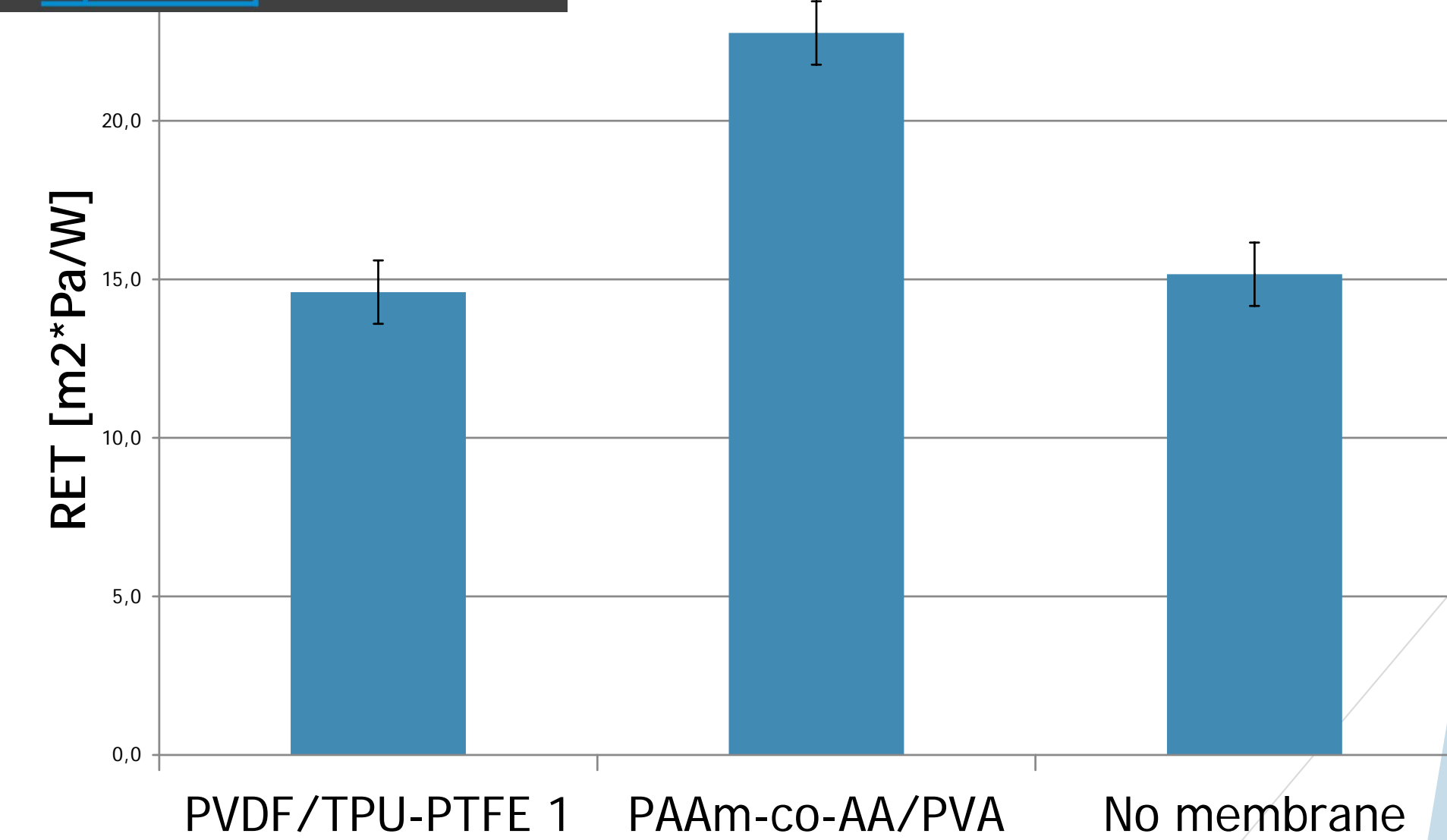
Hours of immersion in water	Membrane weight [g]	Swelling %
None	0.0870	
6 hour	1.1038	1168
32 hours	1.5618	1695
48 hours	1.6420	1787
After 12 hours dry-out	0.0884	

2. Membrane lamination and characterization:

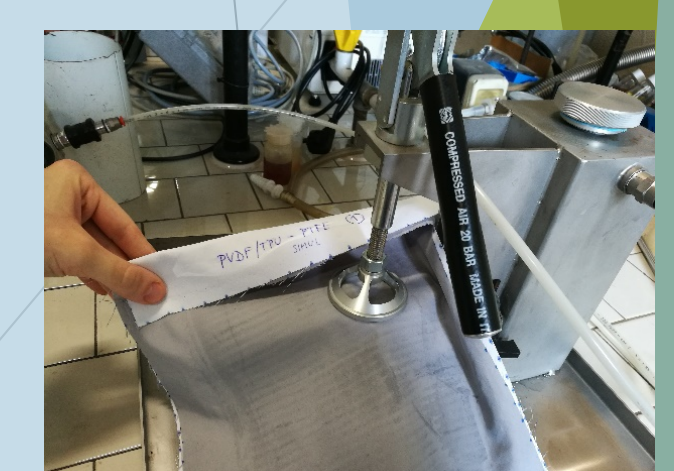
RET (resistance to evaporative transmission)



Lamination: Tubvinyl glue was spread onto textiles and dried 2 mins at 101 °C. Membranes were coupled with prepared textiles and hot-pressed for 4 mins with the pressure of 100 bar and temperature of 105 °C



Water column



Material	Pressure (bar)/m H ₂ O column (m)
No Membrane	0,3/3
PVDF-PTFE/ TPU simul	0,65/6,5

CONCLUSIONS

- Super absorbent membrane were produced by thermal cross-linking of electrospun PAAM-co-AAc-/PVA . Absorption was evaluated by swelling behavior and it has been proved that such membrane can perform a reversible absorption of water equal to 19 times their own weight.
- Different configuration of hydrophobic membrane were produced and characterized; the coaxial membrane obtained with TPU in the shell showed the formation of relatively smooth fibers.
- RET measurements showed a great potential of the super-hydrophobic membranes (no resistance to vapor transmission!), as well as water column tests revealed higher performance (6,5 m) never obtained up to now by such electrospun membrane without any coating.