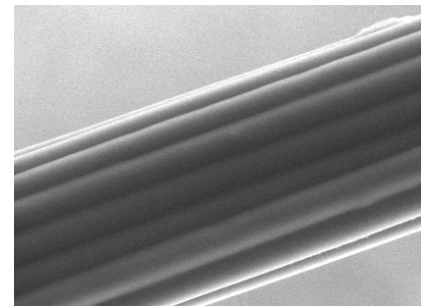


**Biomaterials and Tissue Engineering « Nanoassemblies & Biomimetic Materials »  
INSERM UMR 977**

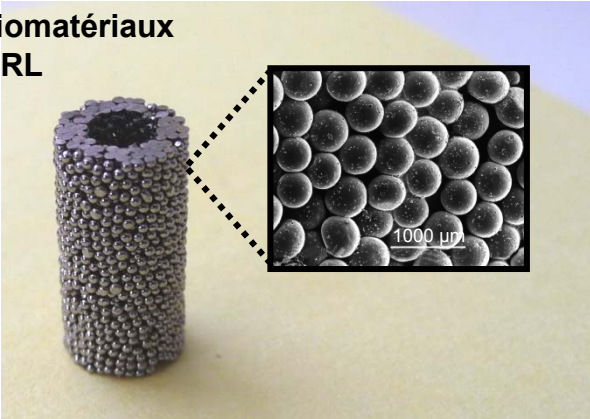
**Apports du MEB aux biomatériaux appliqués  
à la chirurgie ORL et vasculaire**

Dominique Vautier

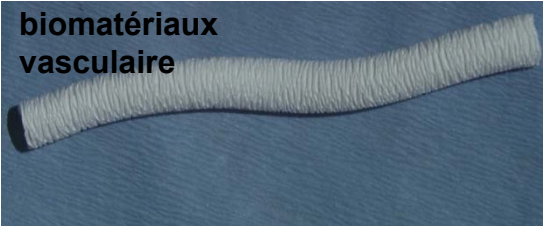


Optimisation de l'intégration de l'implant et sa fonctionnalisation par des molécules spécifiques

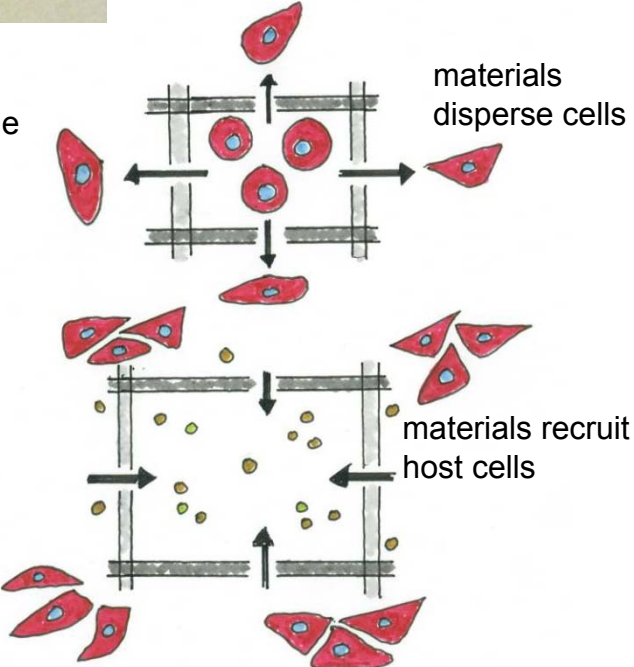
biomatériaux  
ORL



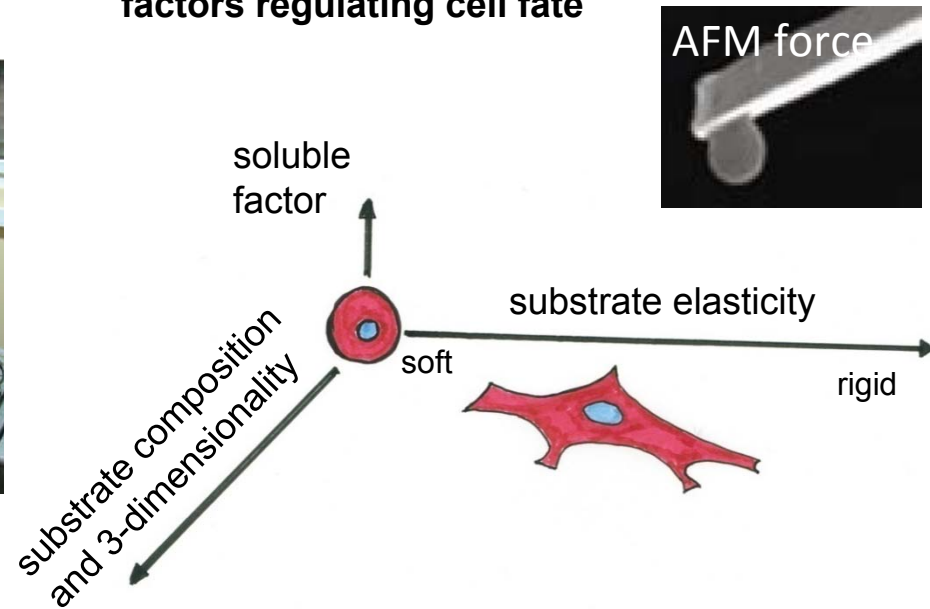
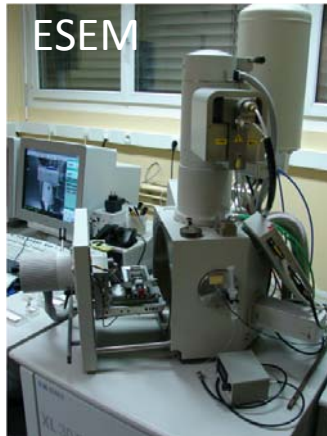
biomatériaux  
vasculaire



Materials from a template for tissue



## factors regulating cell fate



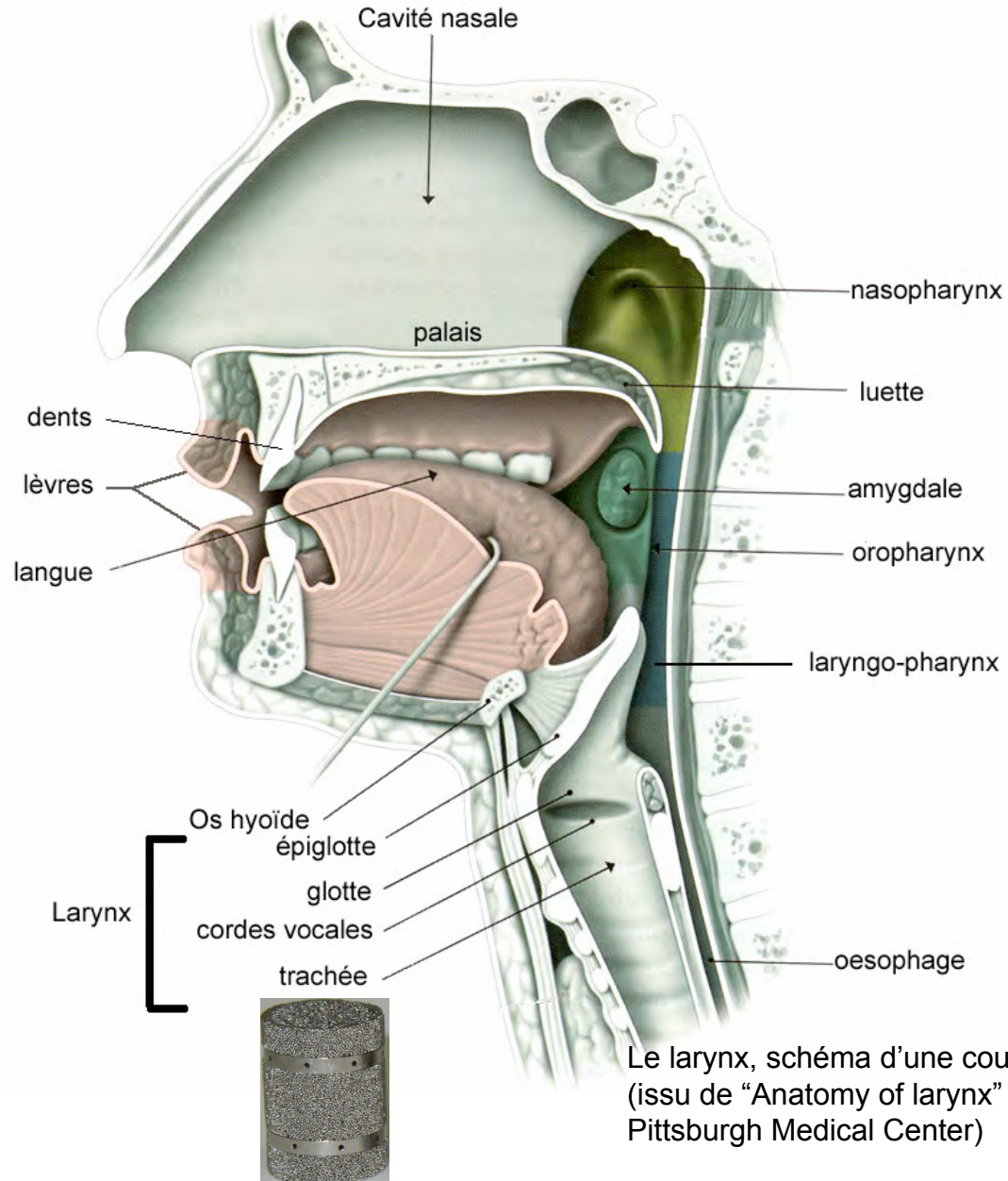


# Prothèse trachéale: integration extra et intraluménale contrôlée

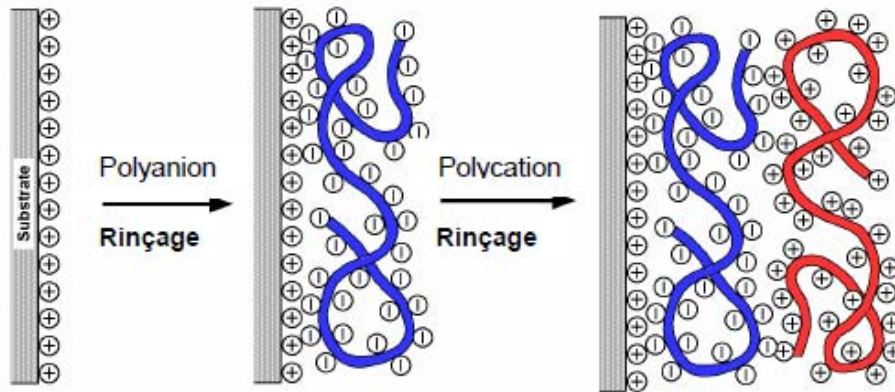
Pr. Christian Debry



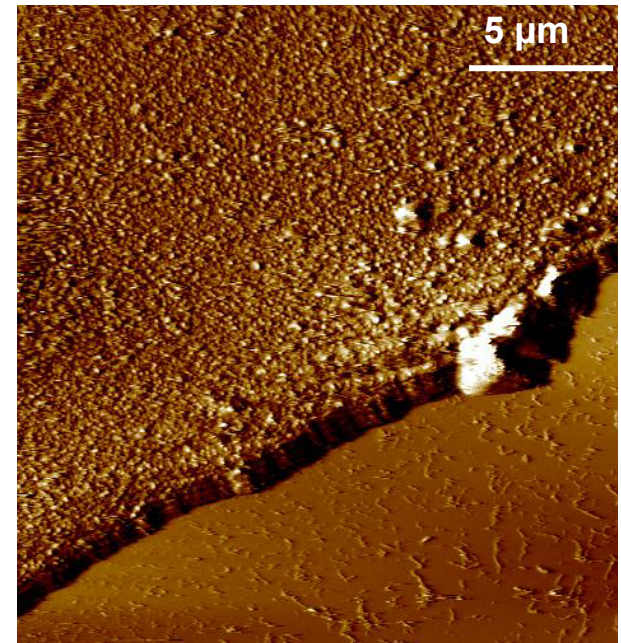
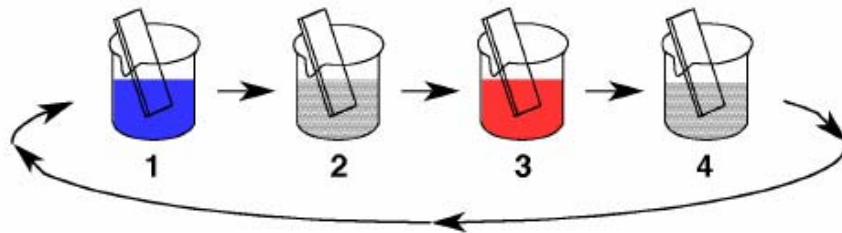
Dr. André Walder

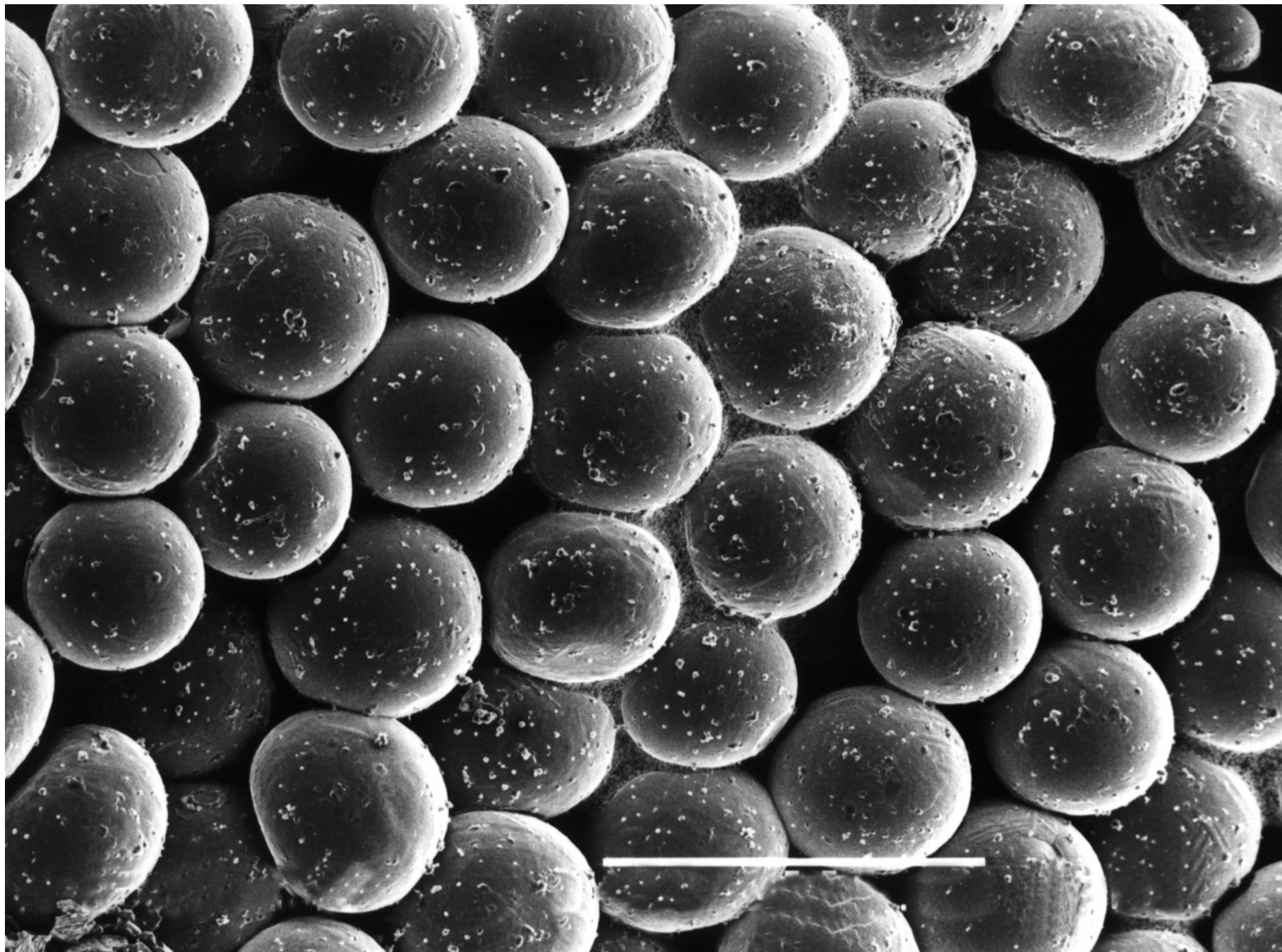


Matrices de synthèse pour le traitement de surfaces de matériaux de substitution dans le domaine biomédicale

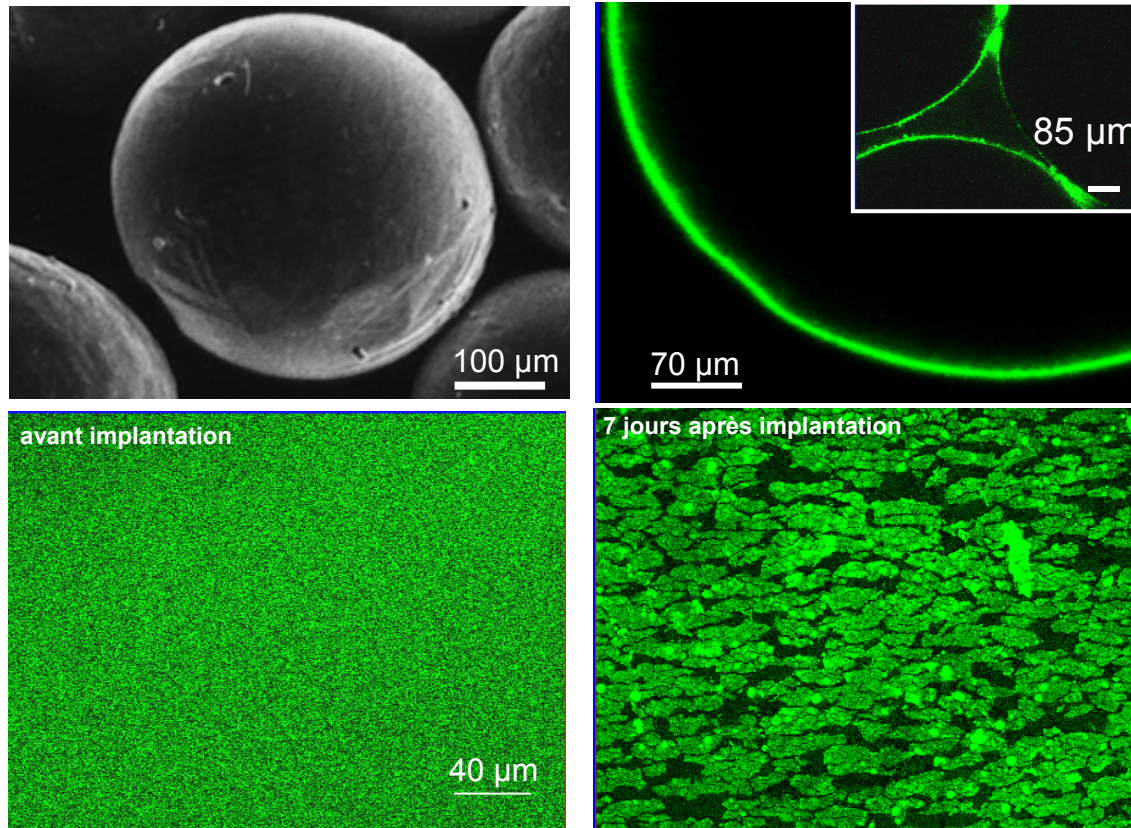


Les films multicouches de polyélectrolytes





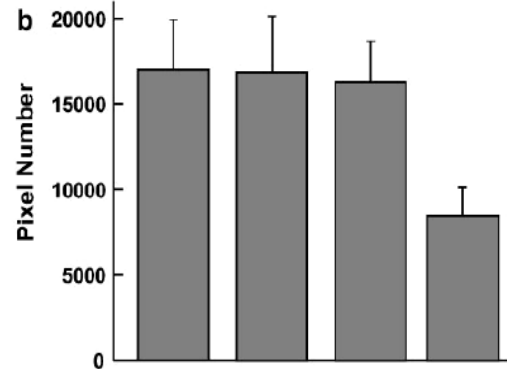
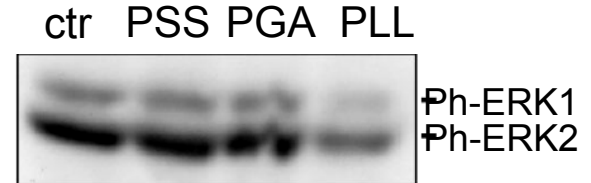
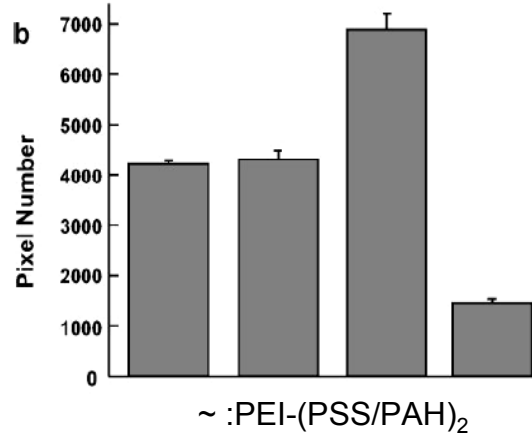
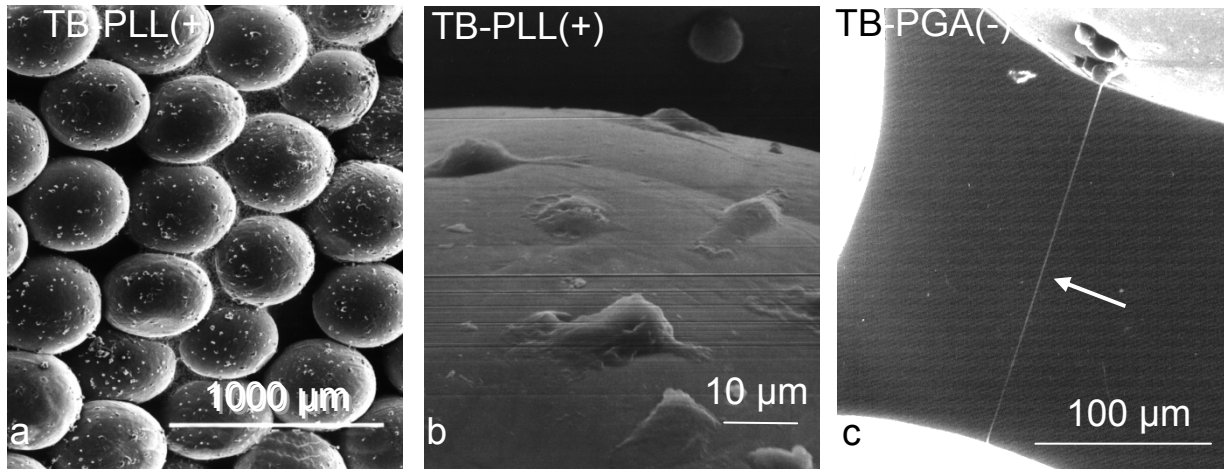
$(\text{PLL-PGA})_4\text{-PLL}^{\text{FITC}}$

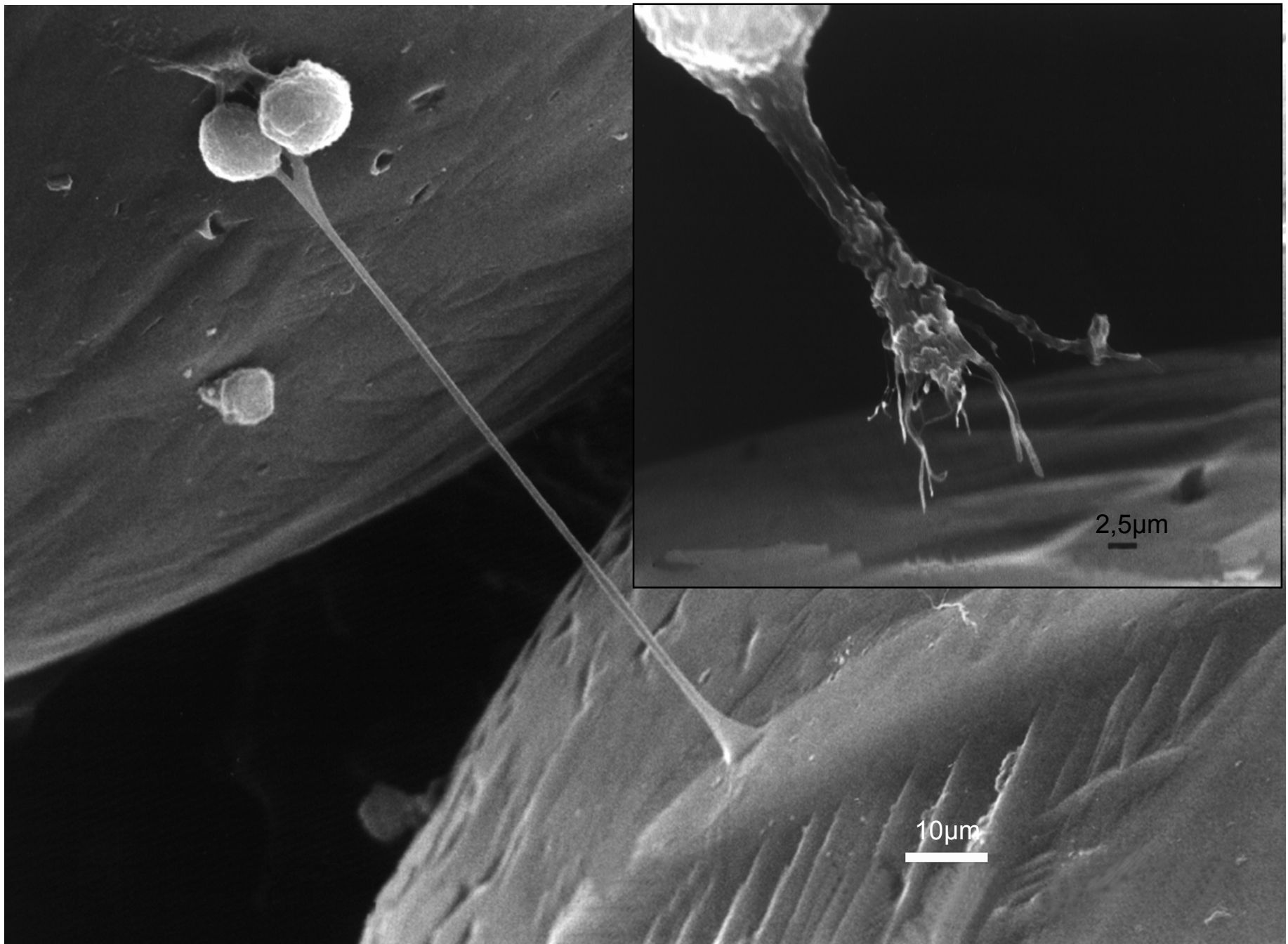


### Dégradation locale du film *in vivo*

- Schultz *et al. Biomaterials* 26:2621 (2005)
- Patent PCT (2005)

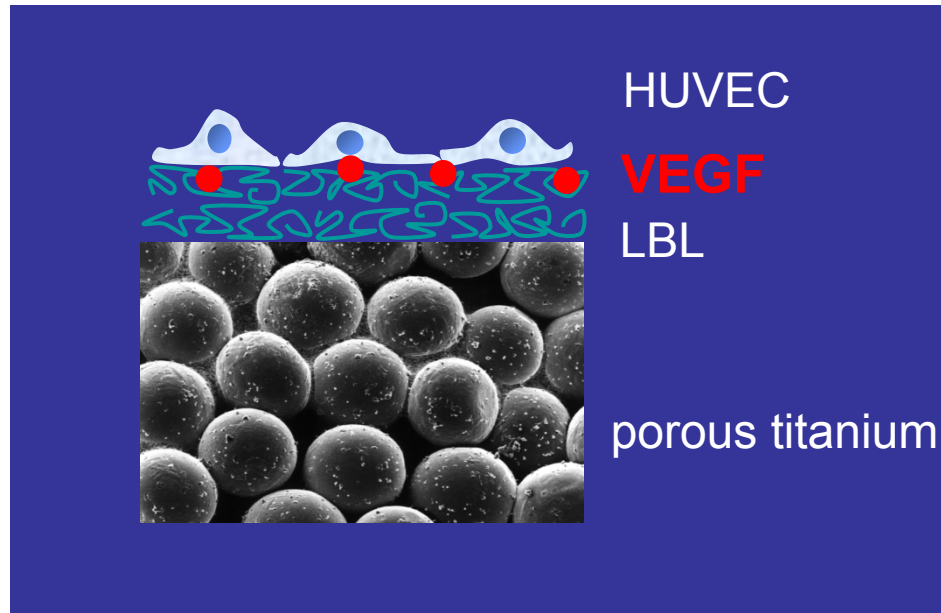
## Topographie et composition chimique



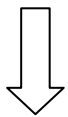
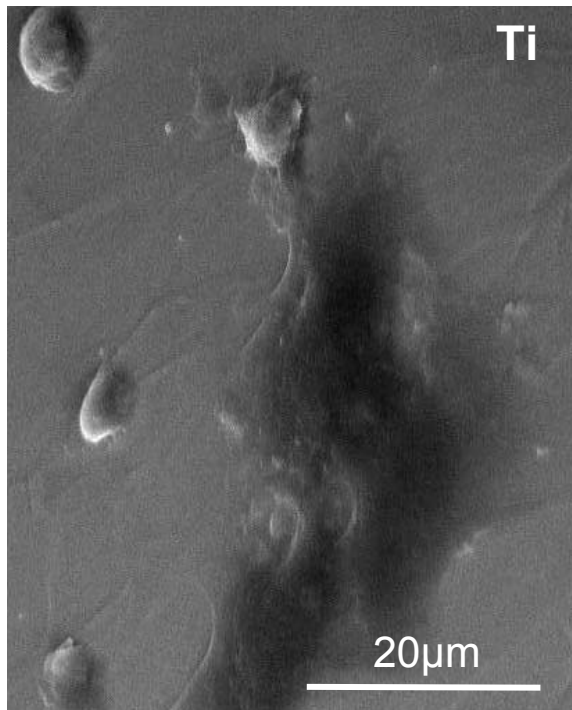


## Design VEGF bioactive coating

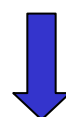
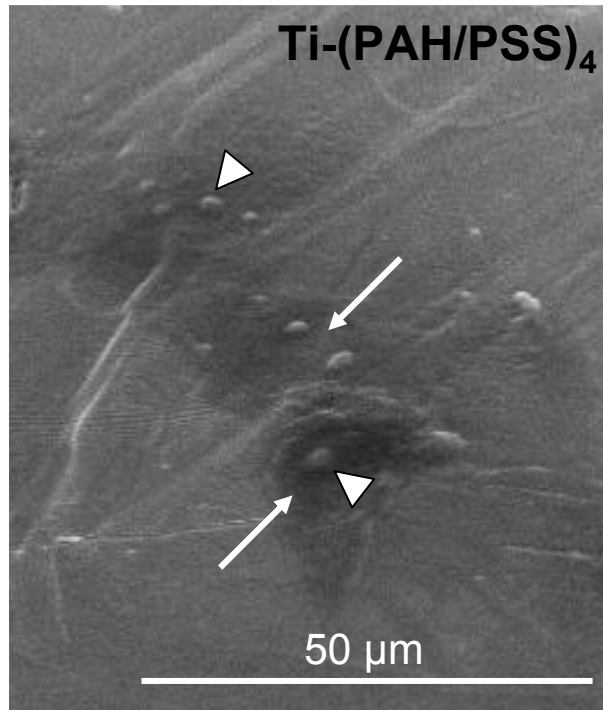
Facteur de croissance VEGF



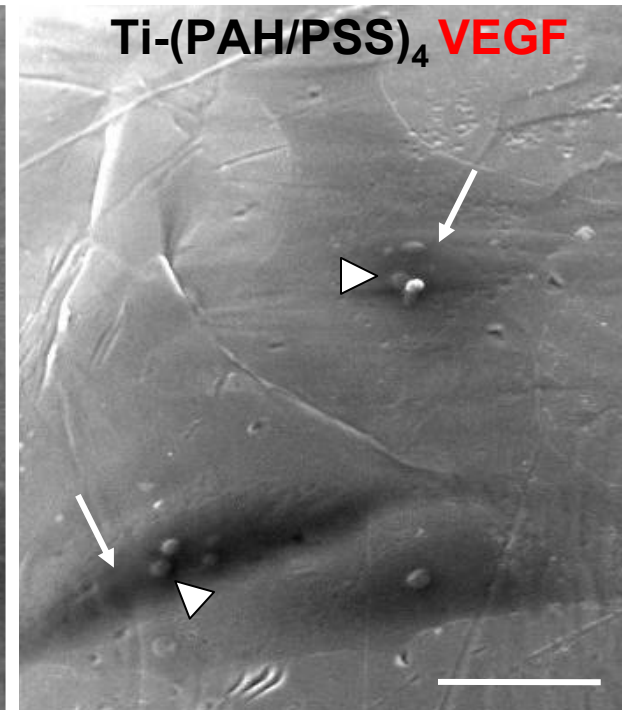
HUVEC growing 24h on titanium beads



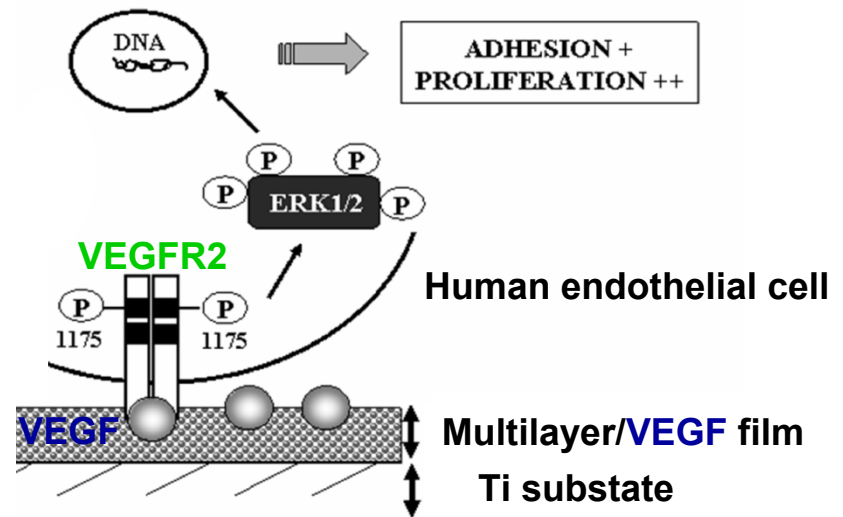
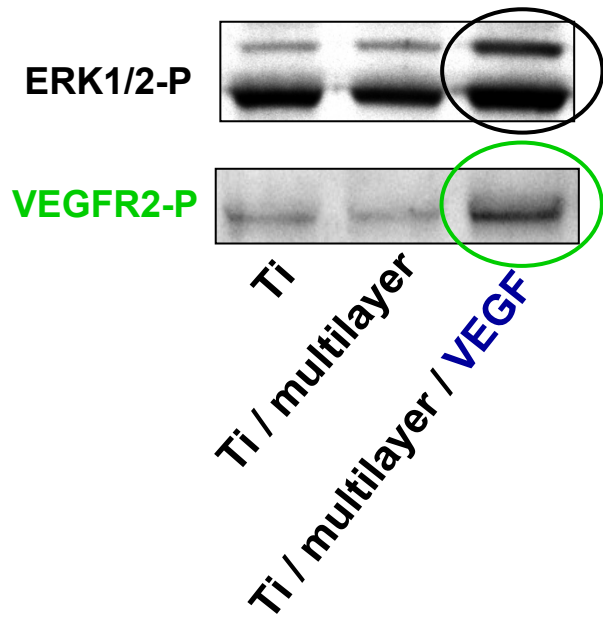
HUVEC displayed  
round-shaped morphology



HUVEC displayed  
**a well-spread morphology**  
(nucleus and nucleolus distinctly visible)



*In vitro* studies



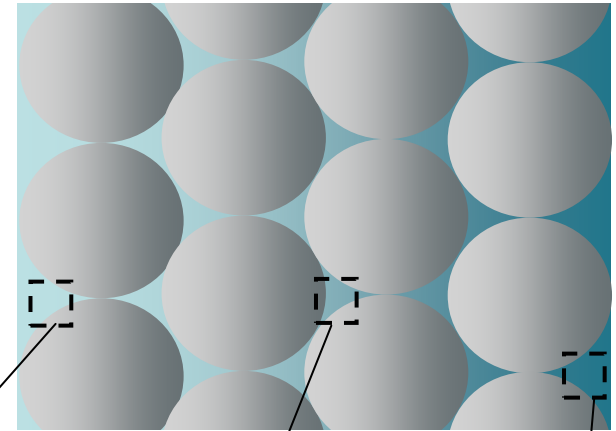
# Titane poreux associé au poly(acide *l,d* lactique) (PLA)

Dr Engin Vrana

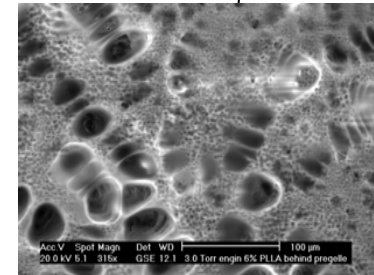
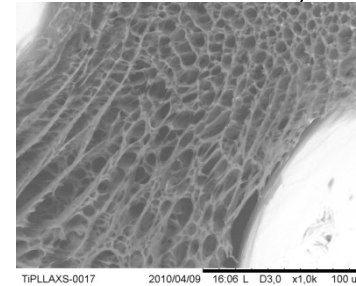
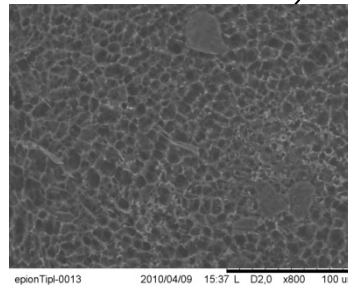


+ PLA

Face  
endoluminale

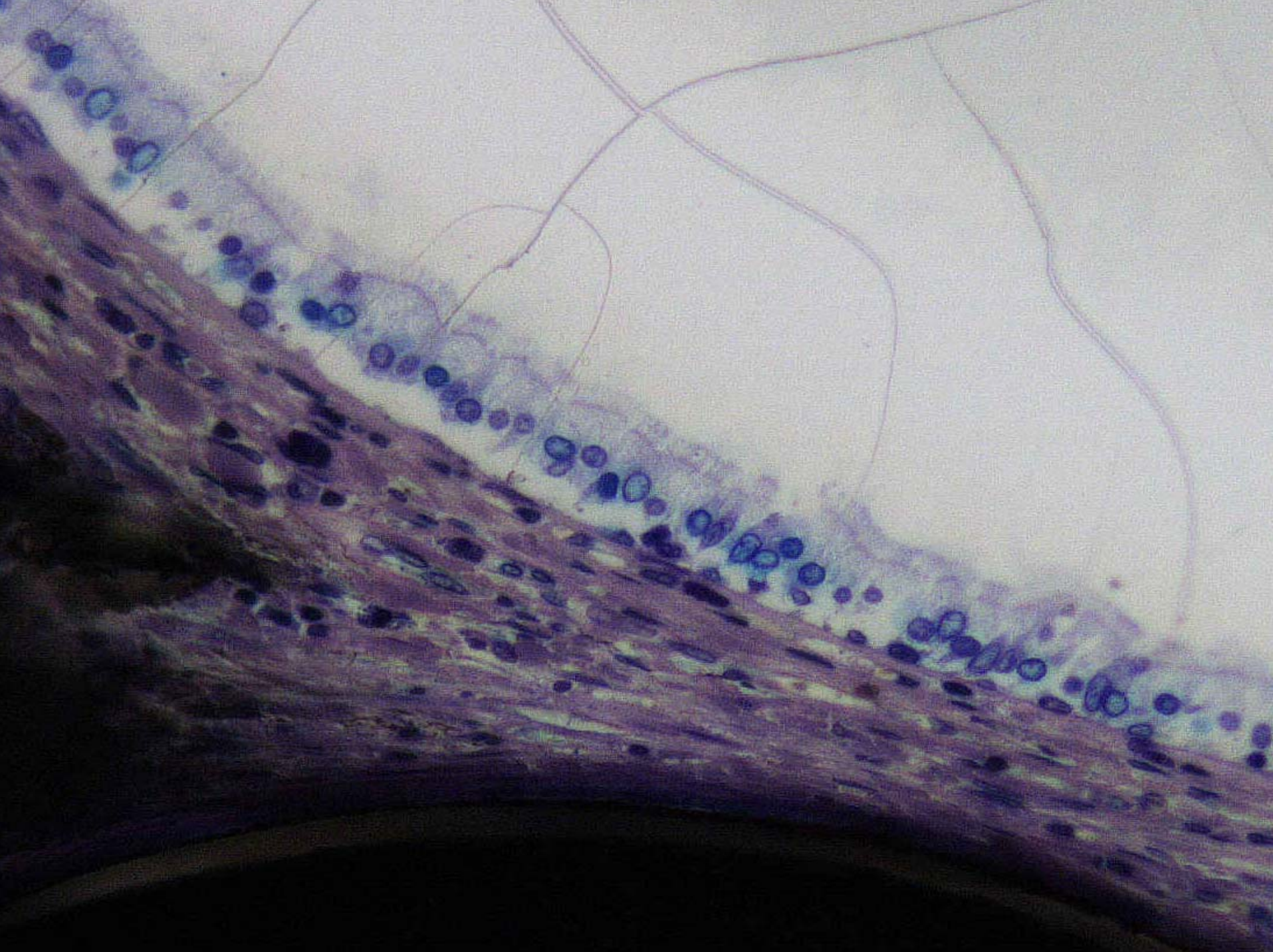


Méthode de "Freeze Extraction"



Vrana et al. PLoS One 39, 410 (2011)

← gradient de porosité  
➤ Limiter la croissance de fibroblastes au niveau endoluminal



# Devenir mécanique de matrice polymérique en recouvrement de surface de prothèse vasculaire en PET



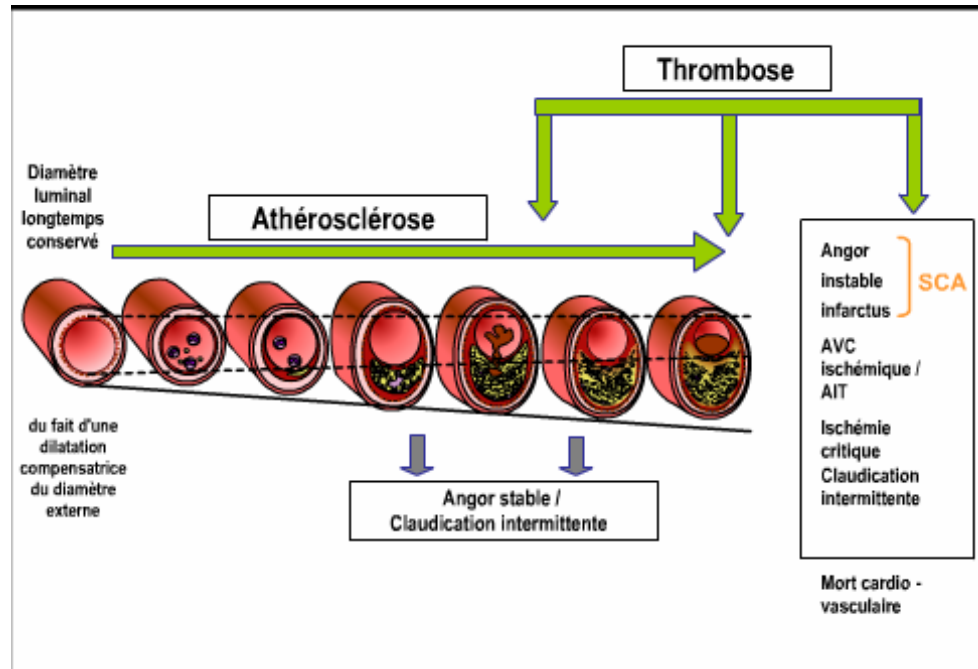
Pr. Simon Rinckenbach



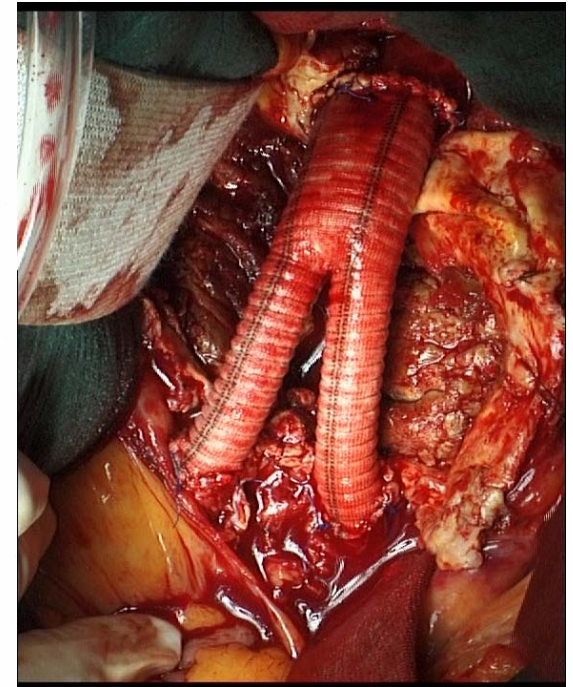
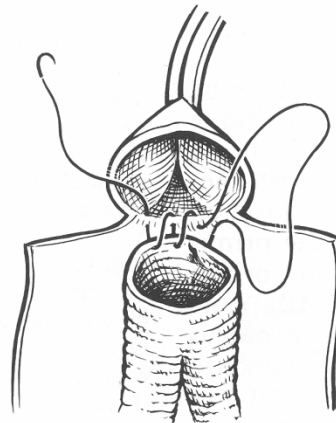
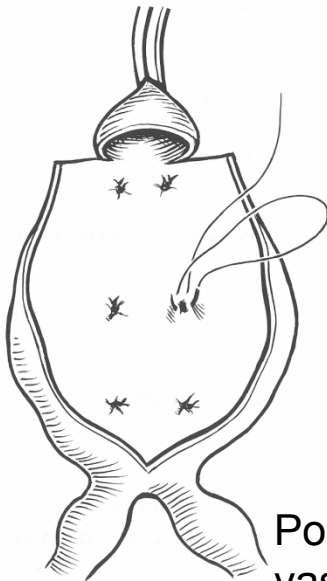
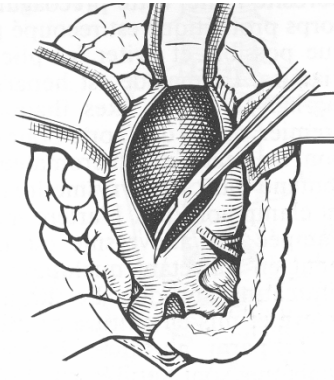
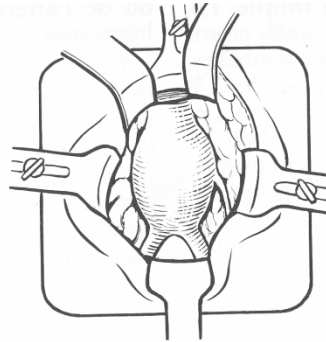
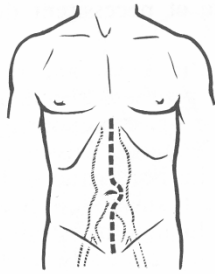
Pr. Nabil Chakfé  
Pr. Bernard Durand

# Cardiovascular pathologies: one of the main causes of morbidity in Western countries

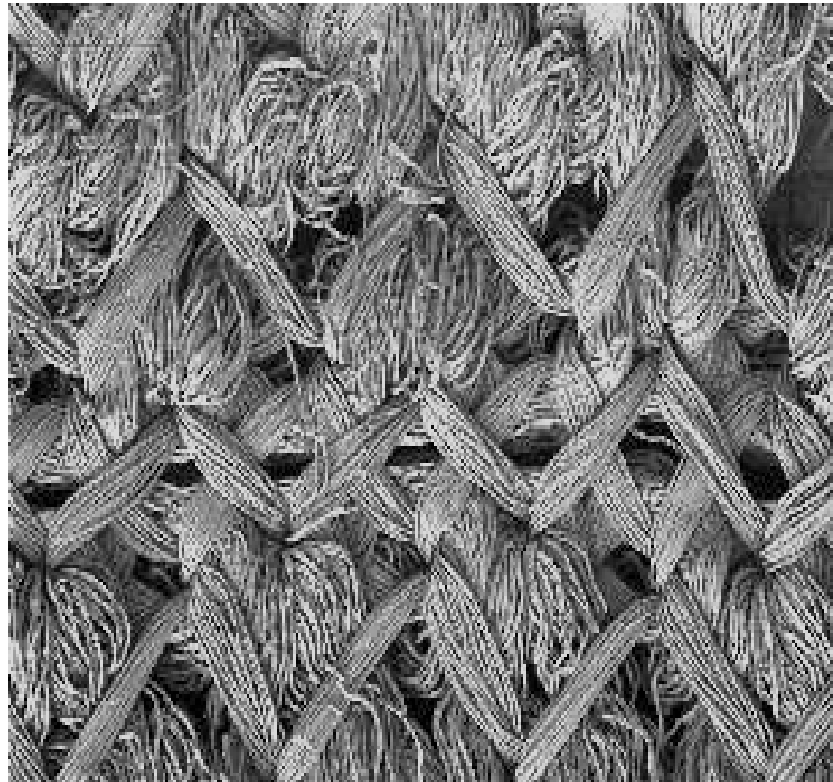
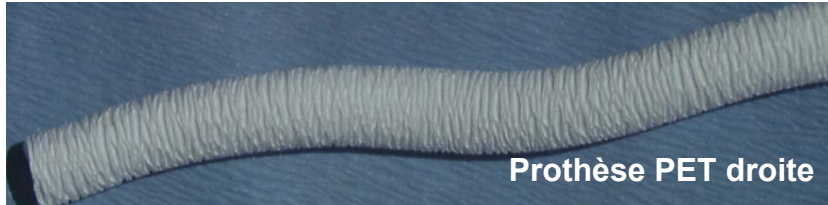
## Invalidating atherosclerosis



→ revascularisation of the affected territories using prosthetic substitutes



Polyethylene terephthalate (PET) vascular prosthesis is the standard for the replacement of large diameter arteries



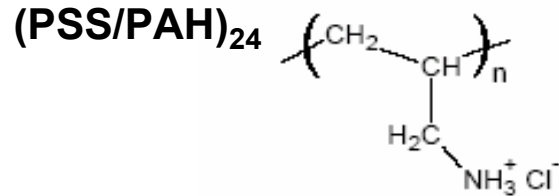
**Prosthesis with high porosity:**

- facilitate healing
- risk of haemorrhage

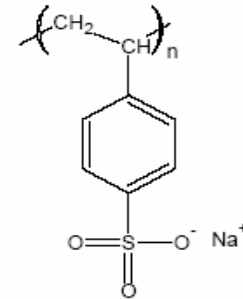
**Textile structure impervious :**

- ▷ collagen
- ▷ patient own blood
- ▶ polyelectrolyte multilayer films

- ⇒ reduce the porosity of the textile structure
- ⇒ promote a monolayer of endothelial cells

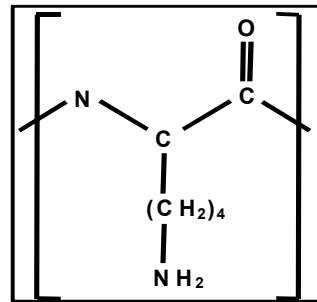


**poly(allylamine hydrochloride) (PAH)**

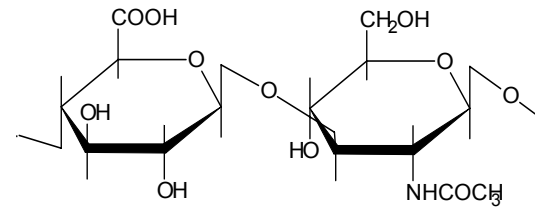


**poly(sodium 4-styrenesulfonate) (PSS)**

**(PLL/HA)<sub>24</sub>**



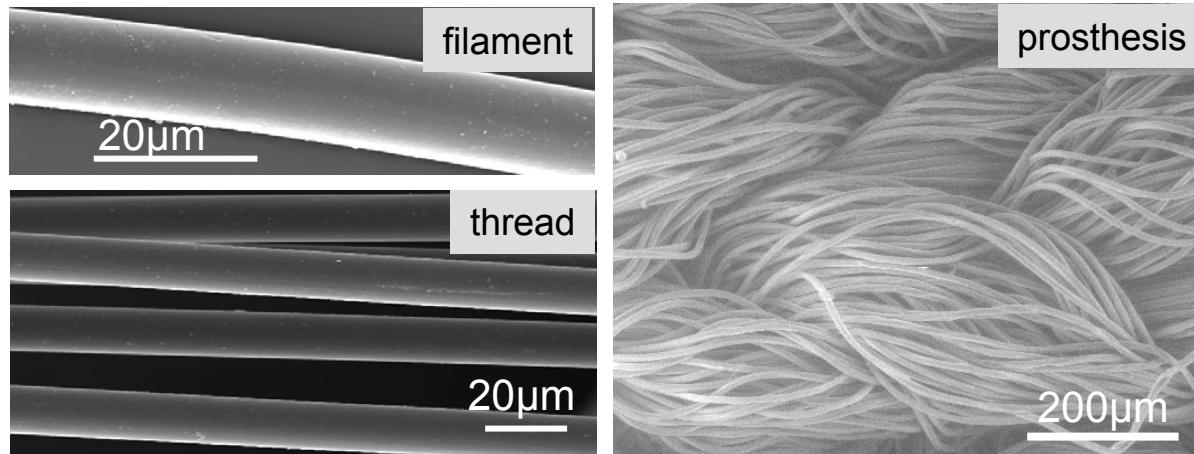
**Poly(L-lysine) (PLL)**



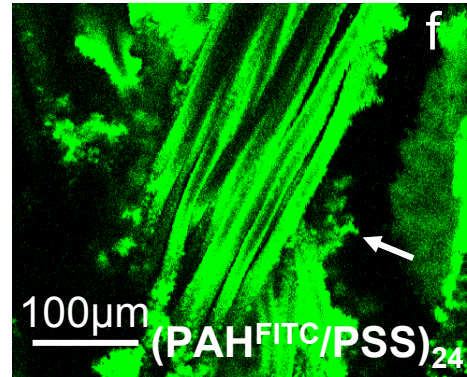
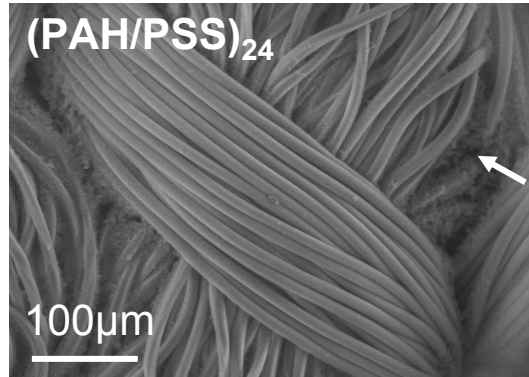
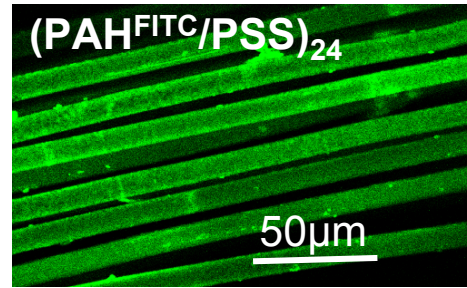
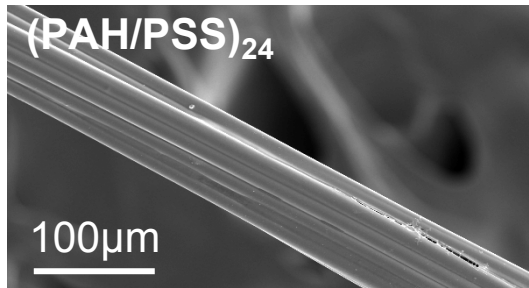
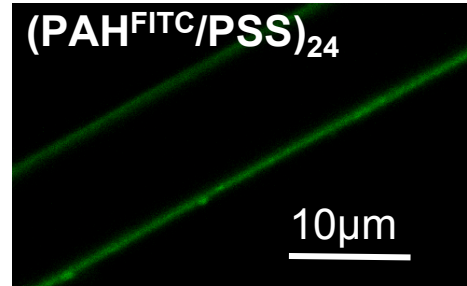
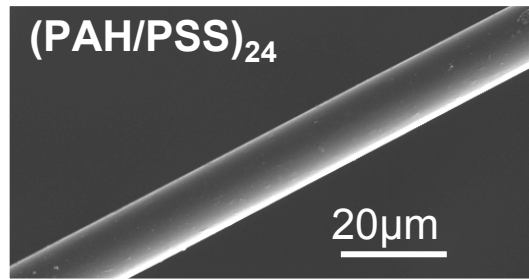
**Hyaluronan (HA)**

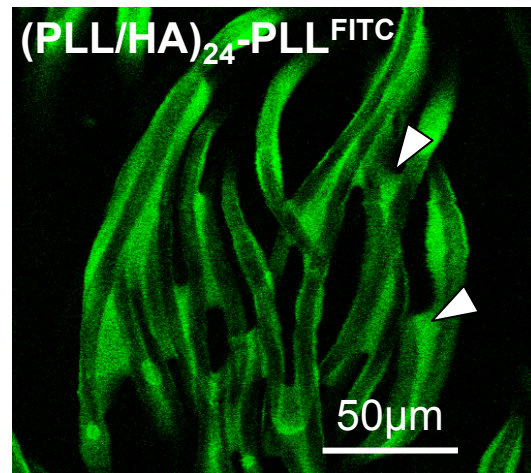
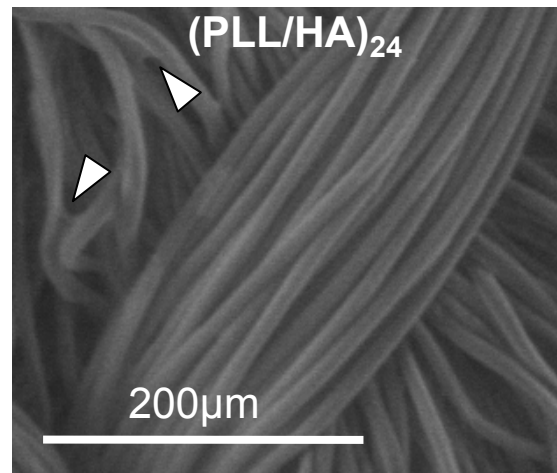
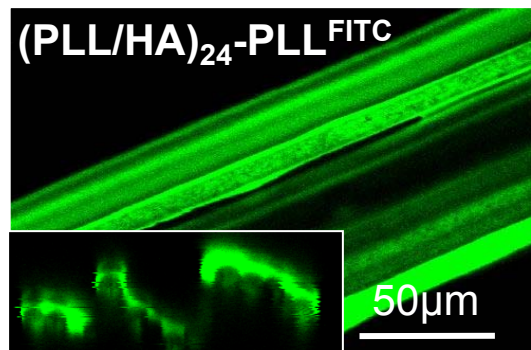
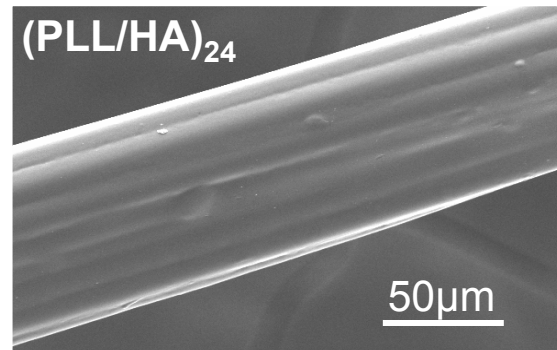
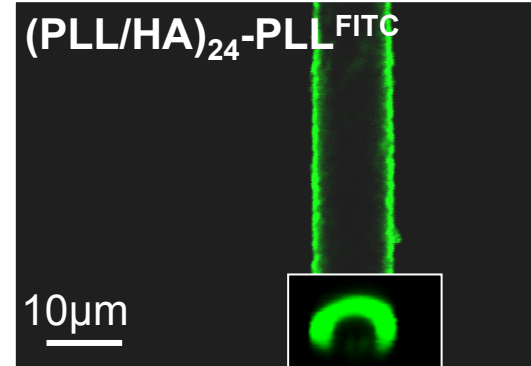
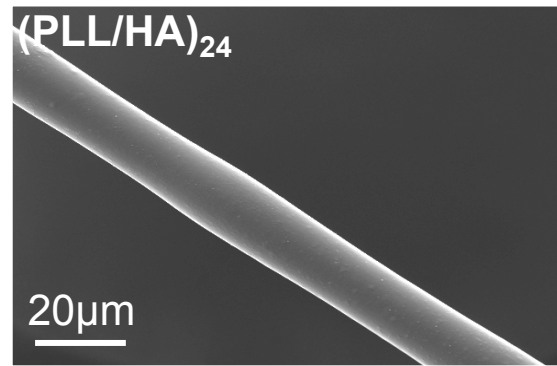
- ▶ Recouvrement des filaments, fils et prothèses par ces deux systèmes de films multicouches est-il homogène?
- ▶ Devenir des ces deux types de systèmes sur filaments après une traction longitudinale?

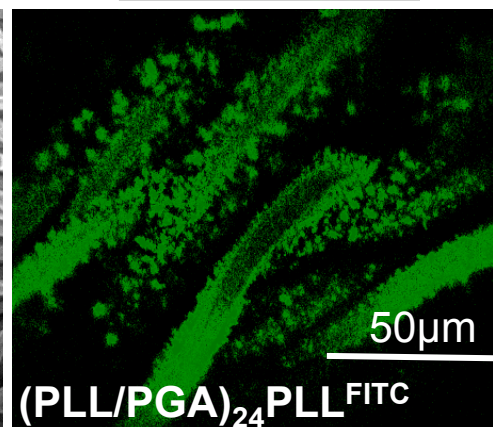
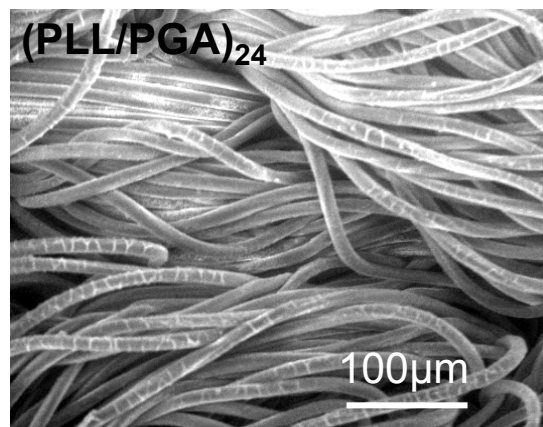
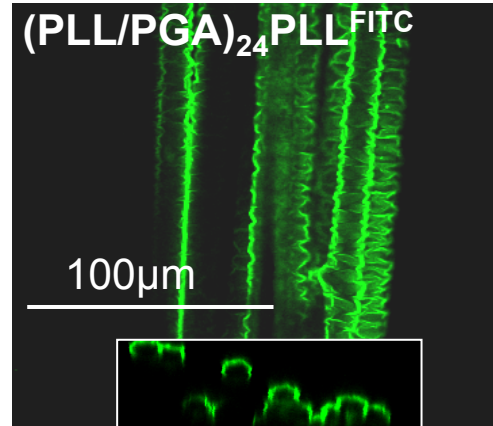
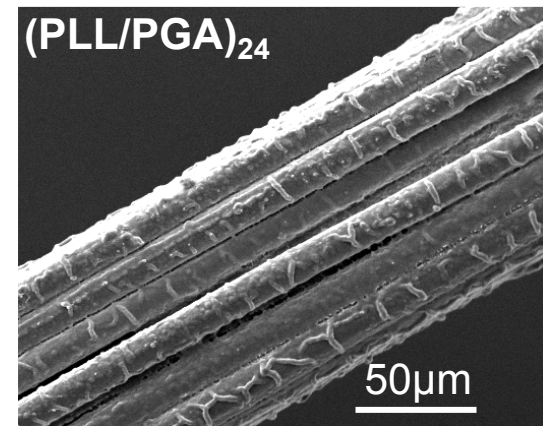
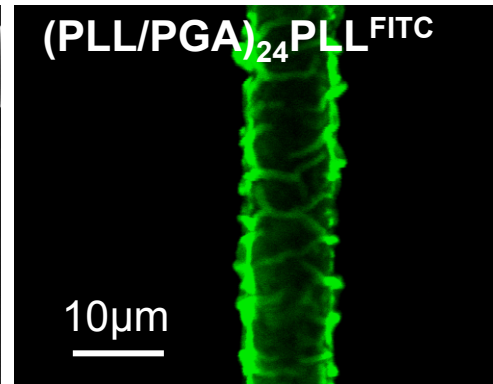
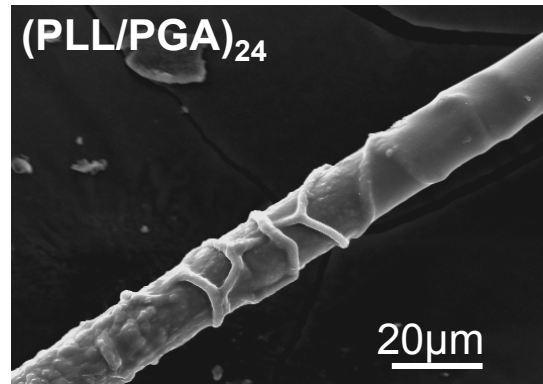
⇒ **Mechanical behaviors of polyelectrolyte multilayers coated on PET vascular prostheses**



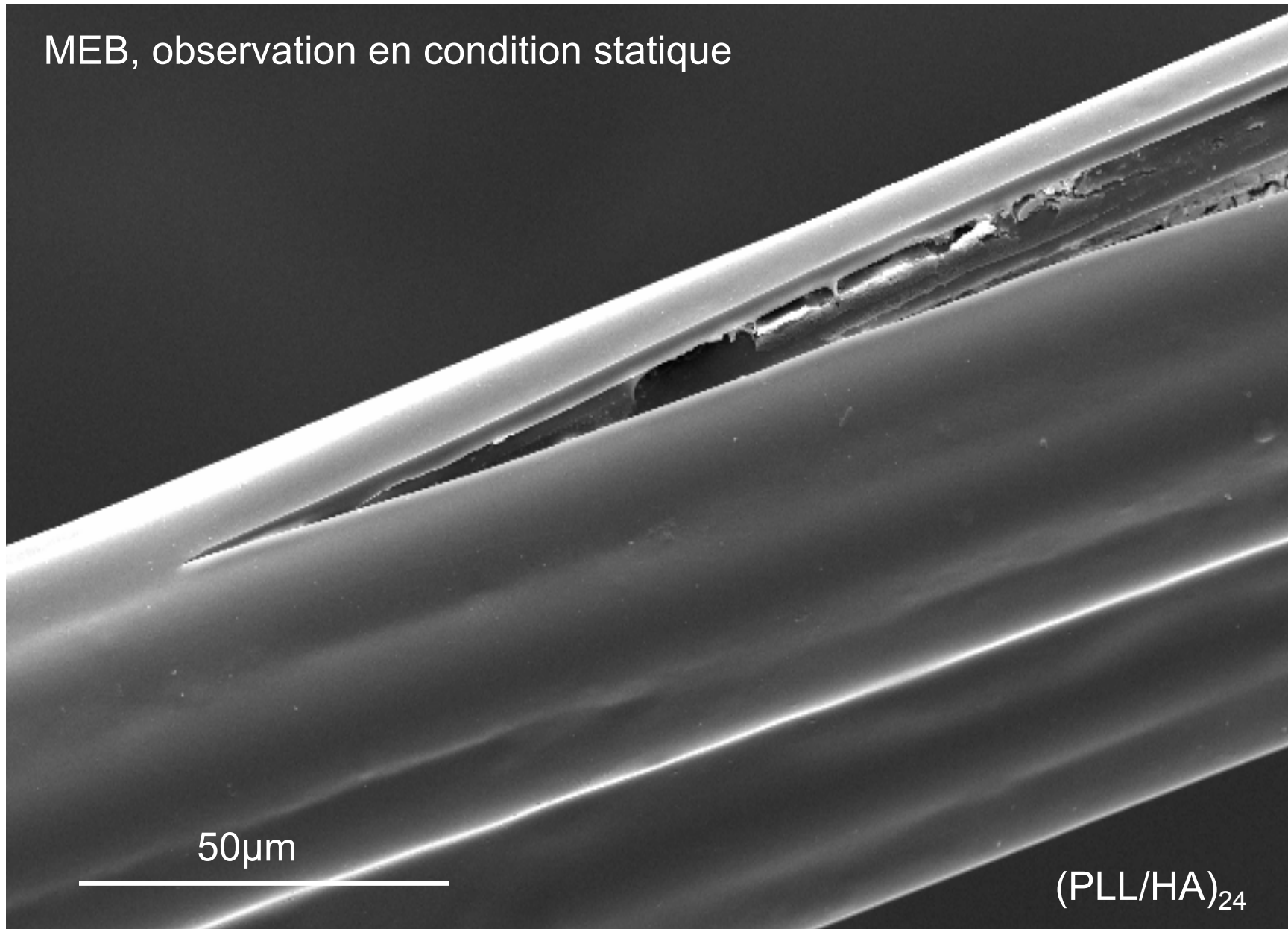
▷ **Static and dynamic characterization**







MEB, observation en condition statique



50 $\mu$ m

(PLL/HA)<sub>24</sub>

# Principe de l'ESEM

- ▷ chambre d'observation à une pression relativement élevée (>10 Torr)

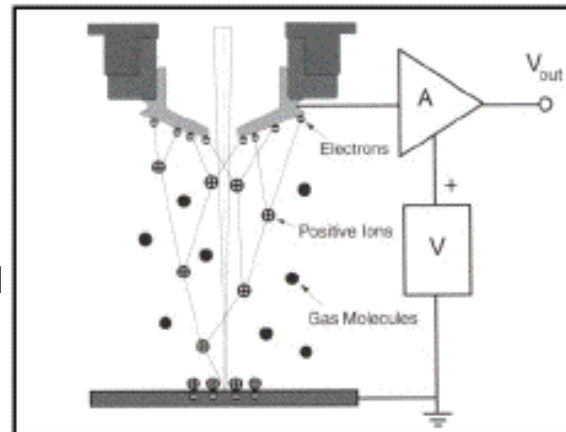
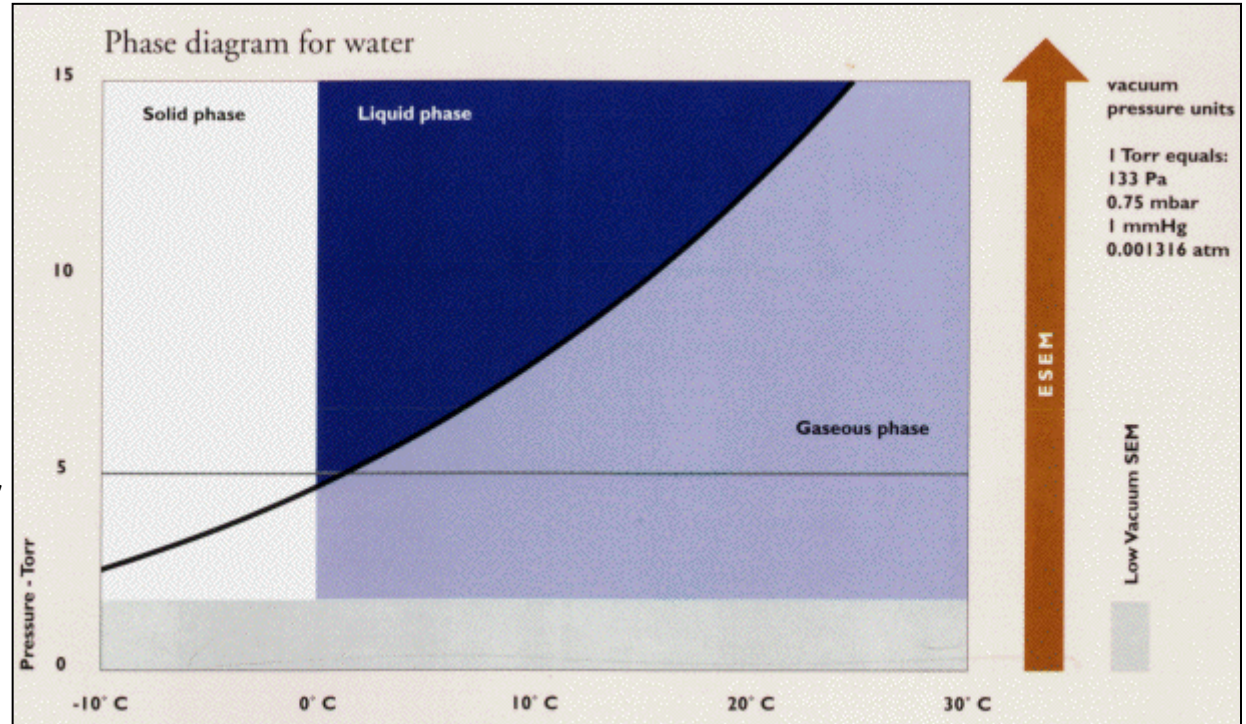
Eau: 10 Torr  
15°C ⇒ **liquide**

- ▷ **Pas nécessaire de déshydrater Les échantillons humides**

- ⇒ humidité relative = 80%  
échantillon non conducteur

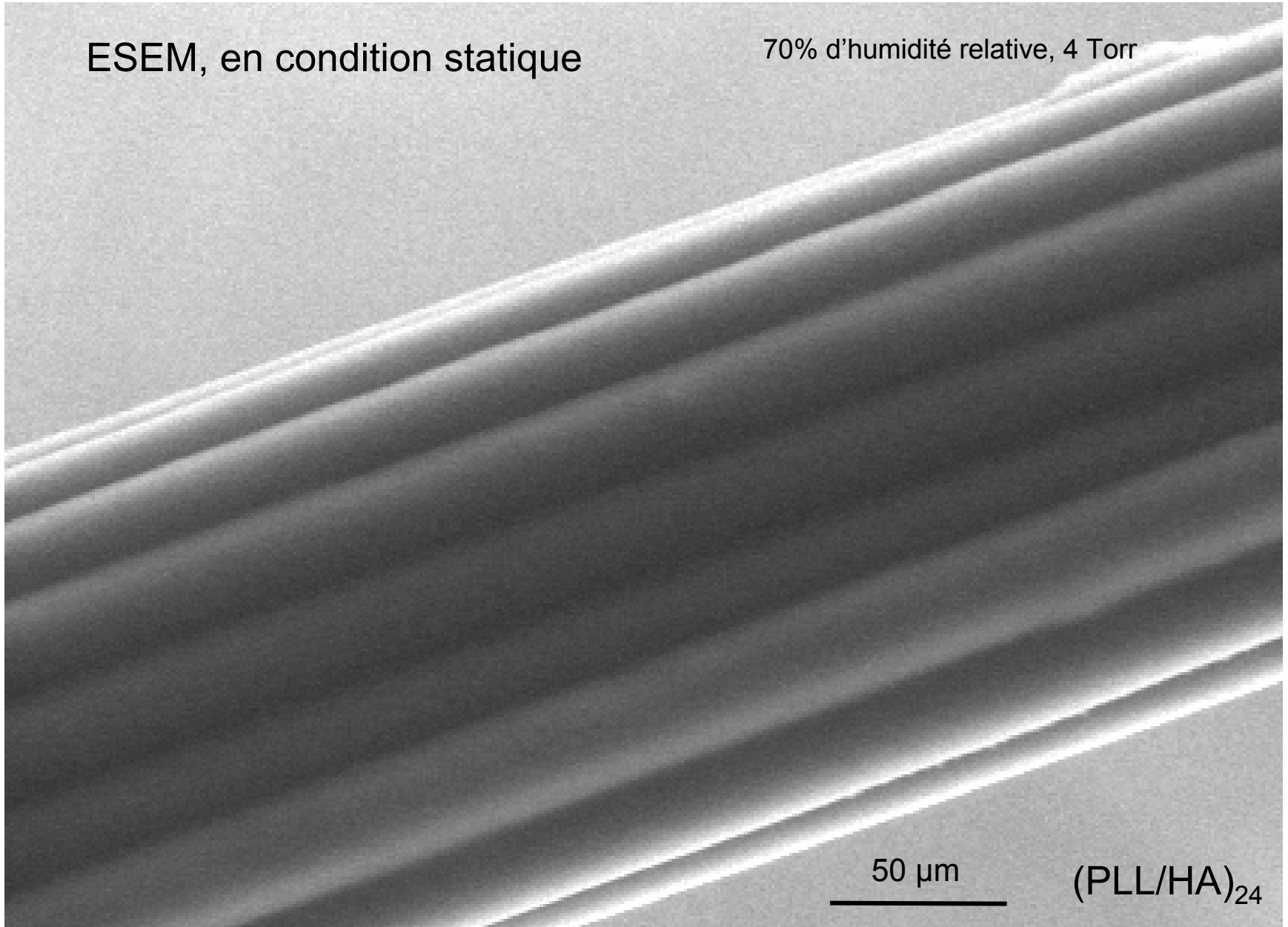
détecteur e secondaires remplacé par un détecteur gazeux  
gaz environnant servant d'amplificateur du signal

- ⇒ **Échantillons non métallisés**



ESEM, en condition statique

70% d'humidité relative, 4 Torr



50 μm

(PLL/HA)<sub>24</sub>

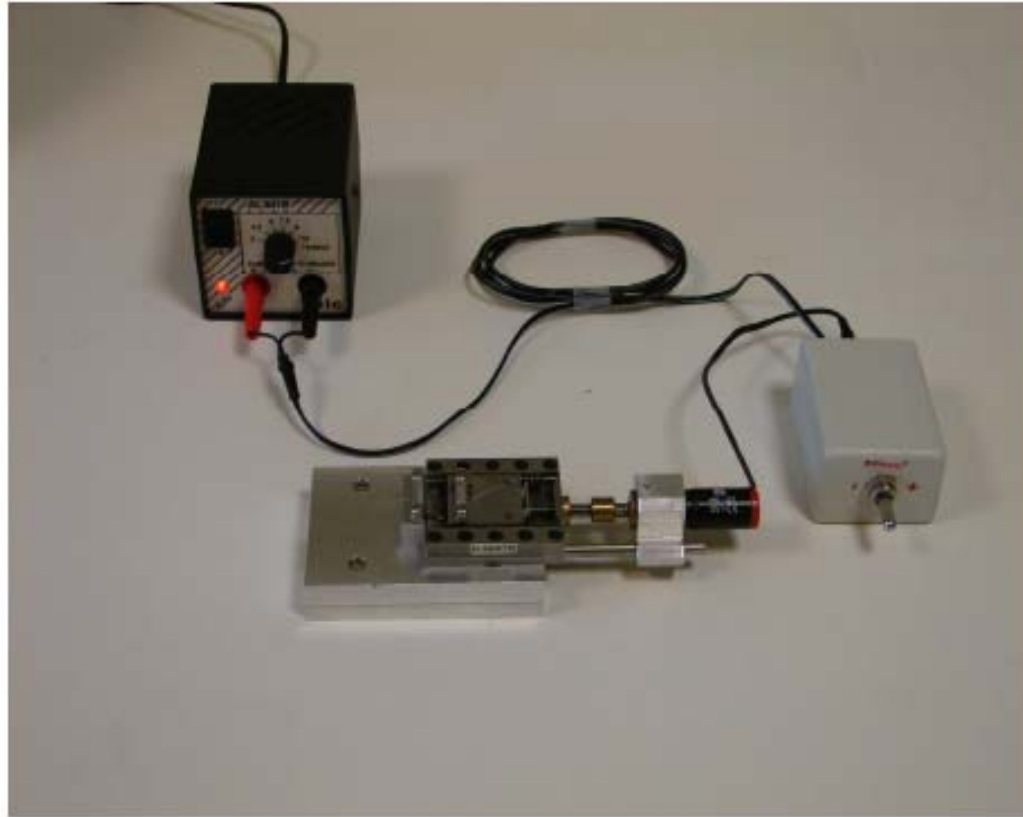
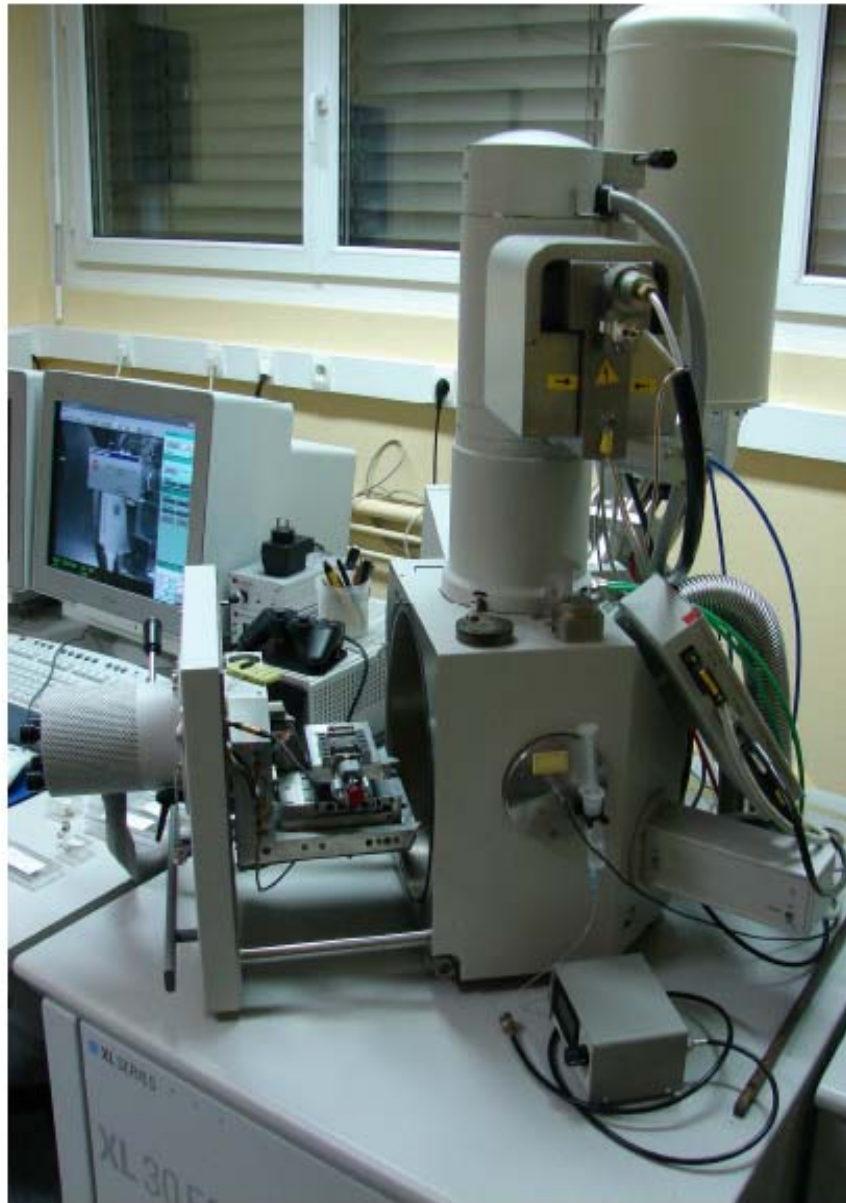


Figure 2.5.1.2d : Le système de traction.



**Figure 2.5.1.2e : Le système de traction dans l'ESEM.  
Philips XL 30, Pr Jean-Hervé Lignot**

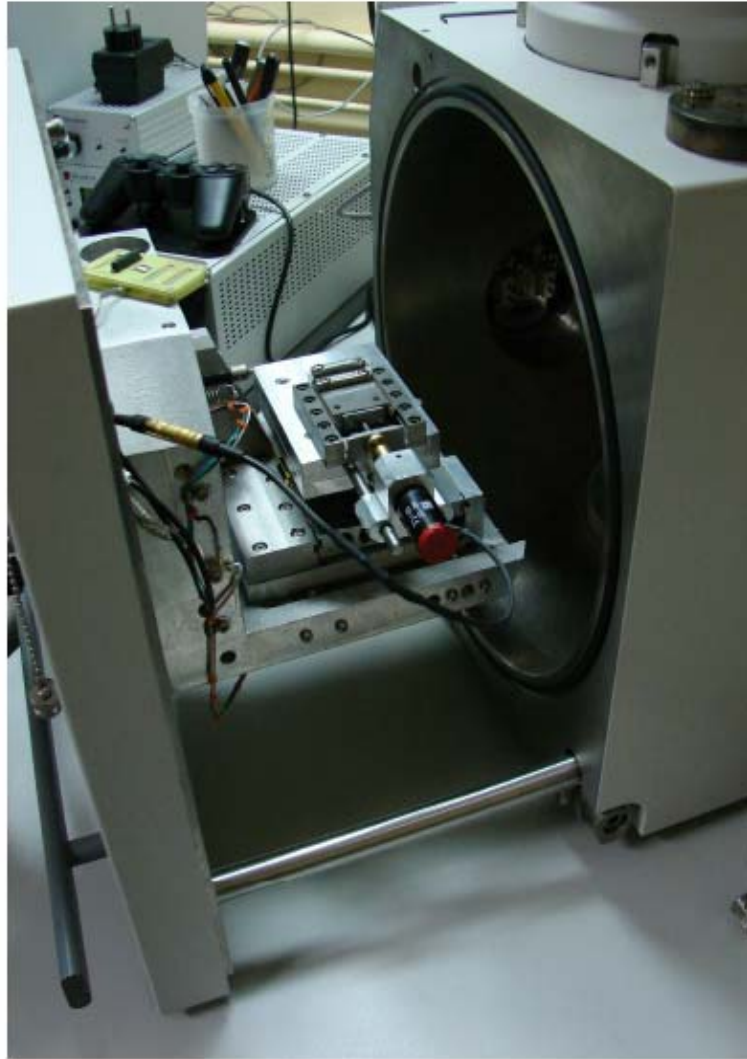
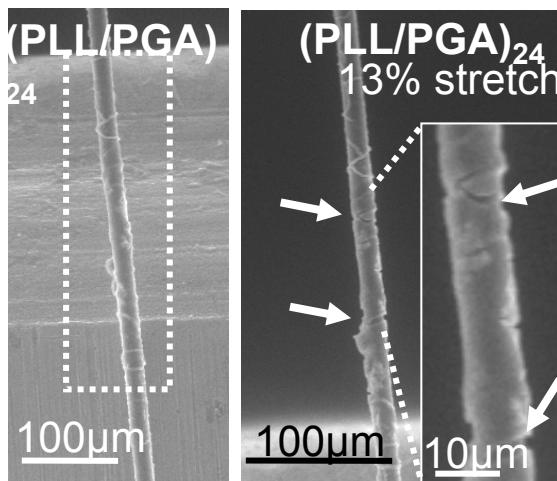
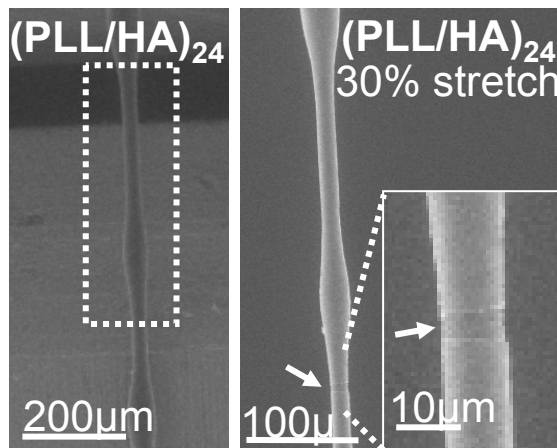
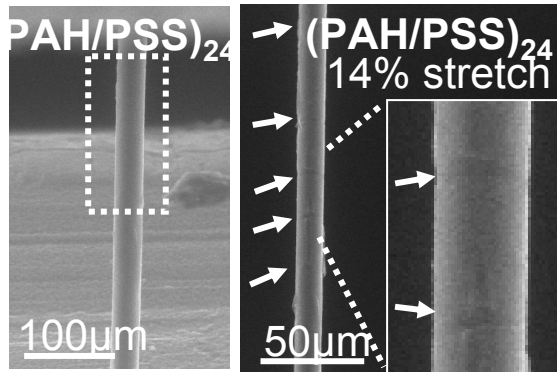
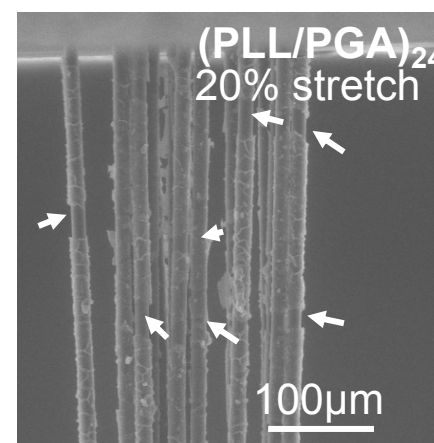
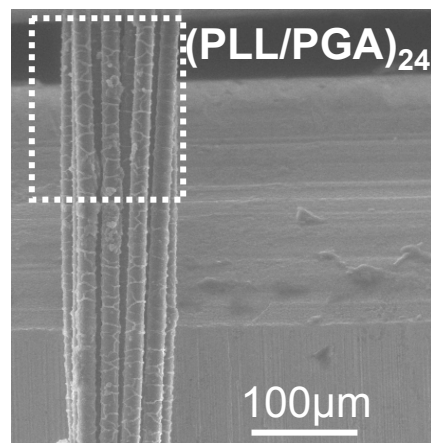
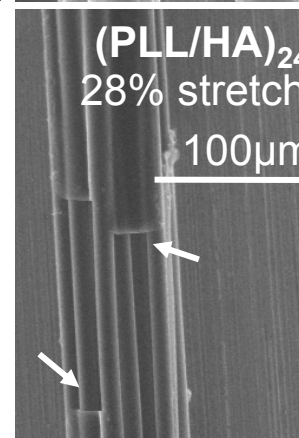
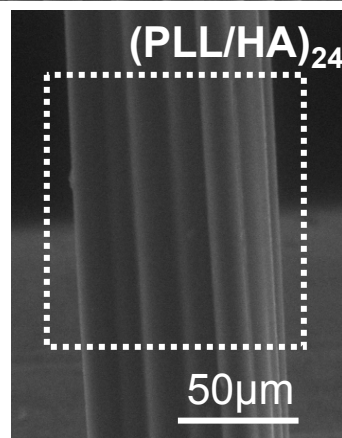
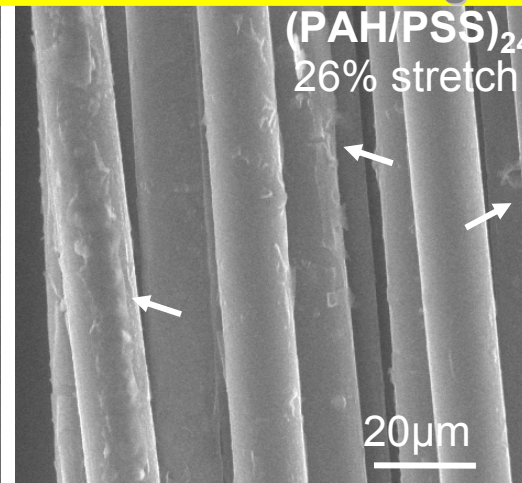
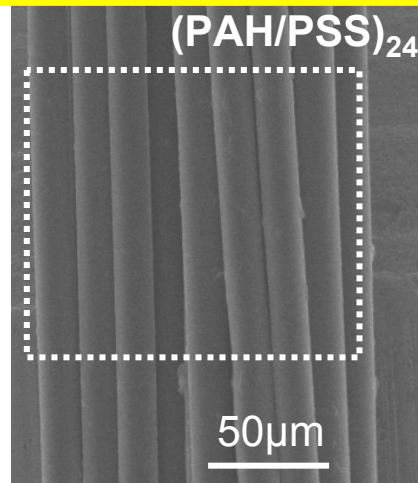


Figure 2.5.1.2f : Détail du système de traction placé sur la platine d'observation de l'ESEM.

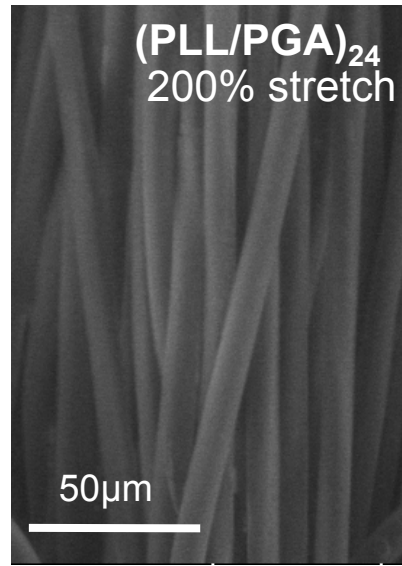
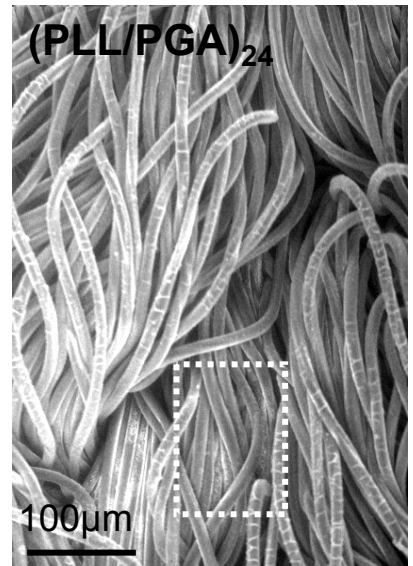
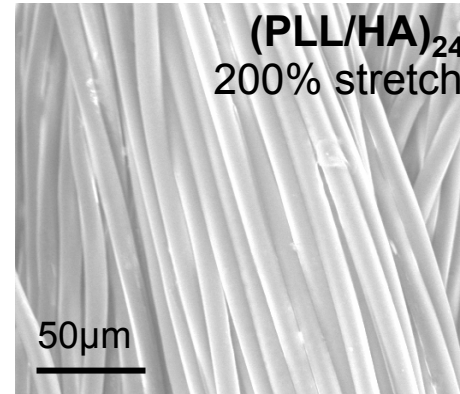
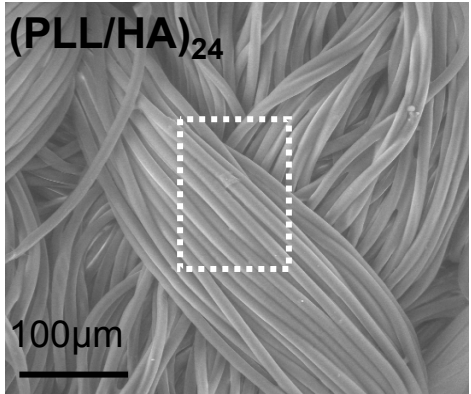
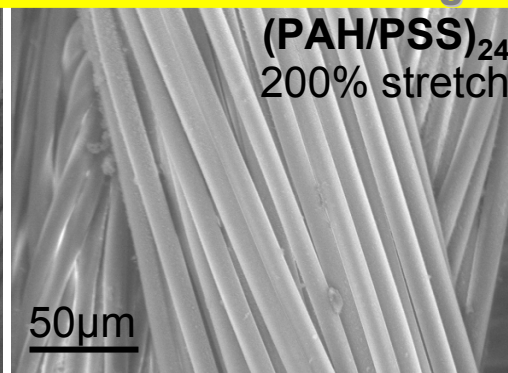
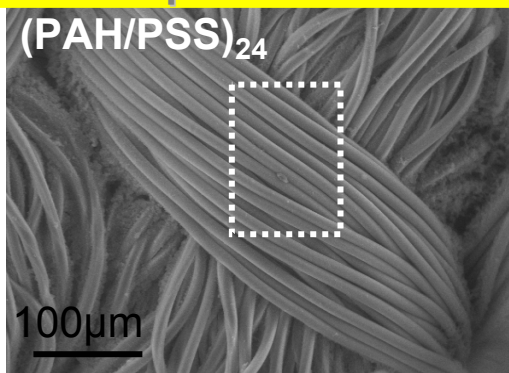
filament under mechanical stretching



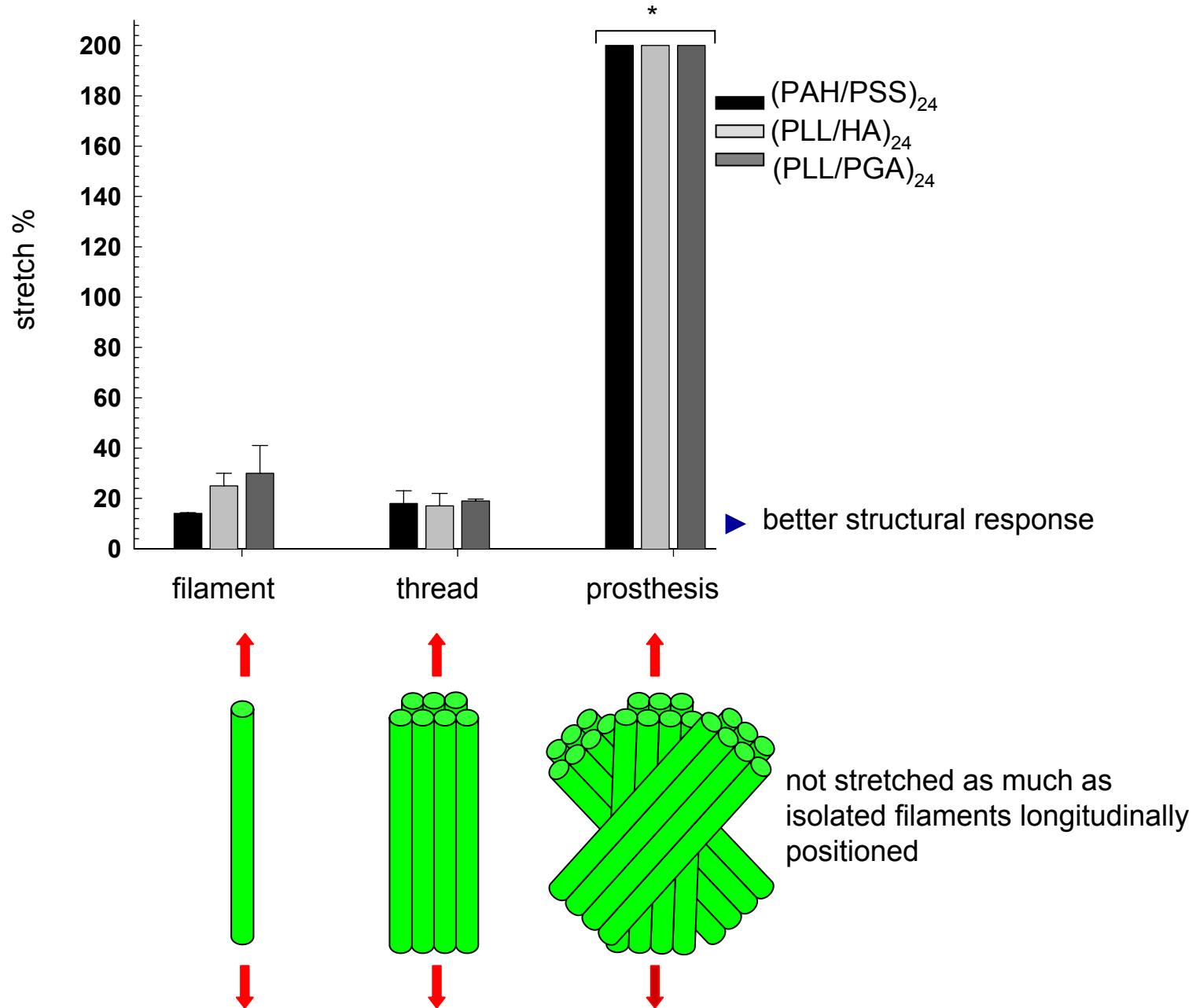
thread under mechanical stretching



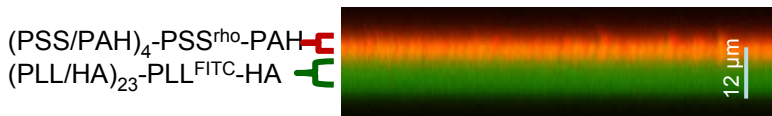
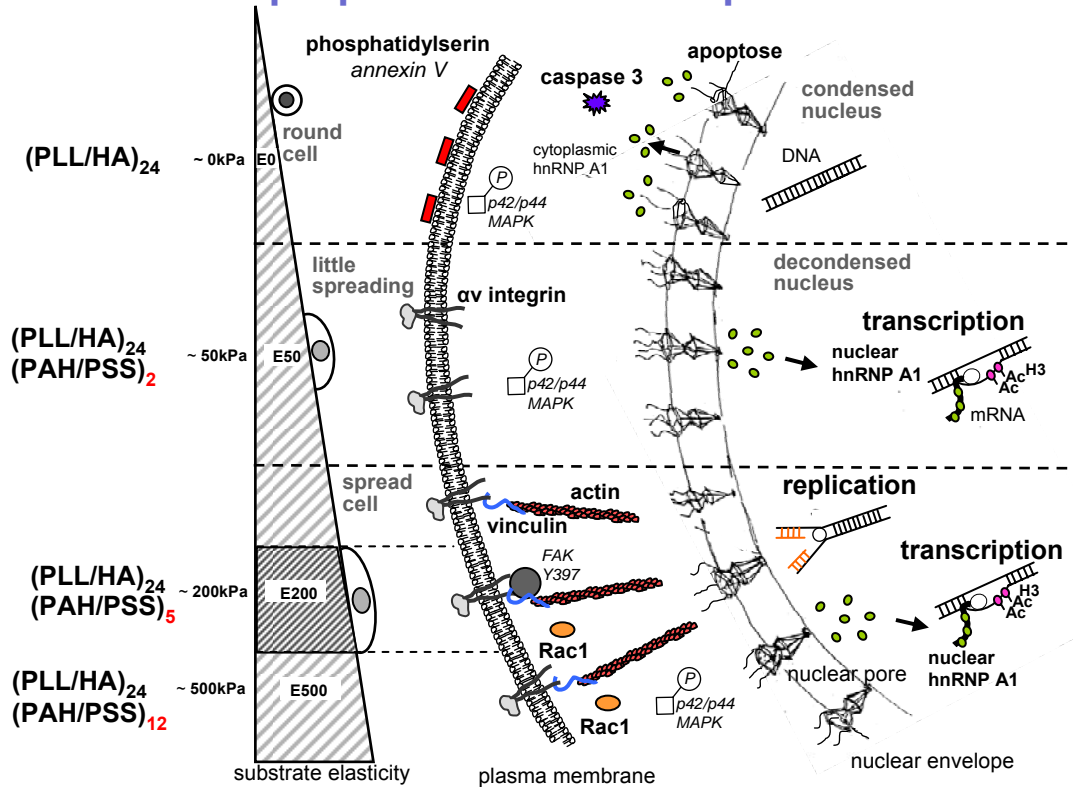
prosthesis under mechanical stretching



# prosthesis under mechanical stretching



# Relation entre propriétés viscoélastiques du substrat et comportement cellulaire



A un module de Young de 50 kPa, l'absence de contacts focaux et de fibres de stress d'actine empêche l'activation de la réplication mais pas de la transcription

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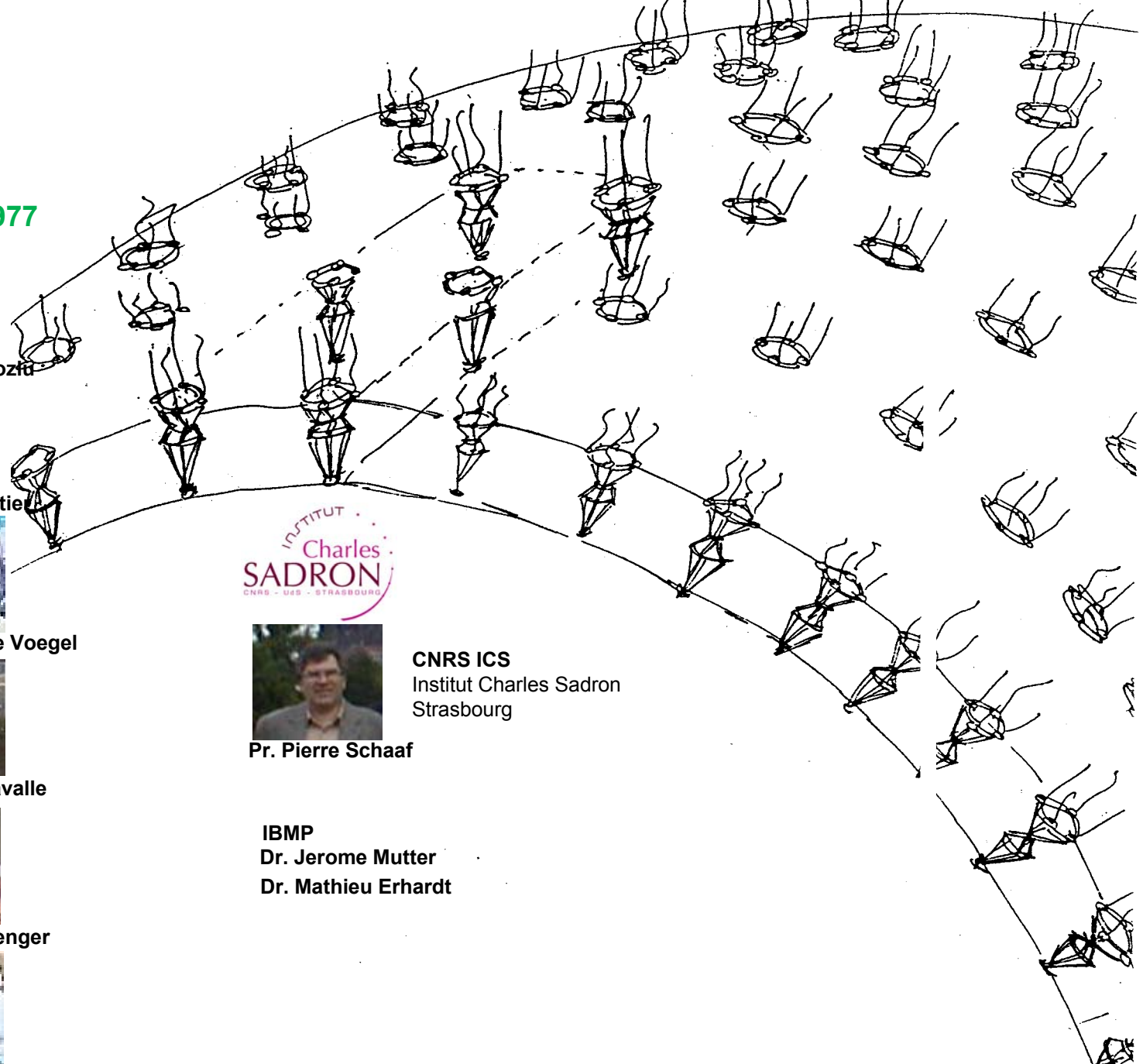




Table 1. Projections occurrence and length of HCS-2/8 cells adhered on TB samples

	n	Length of the cell ( $\mu\text{m}$ )	% of cell with protrusion	Length of the protrusion ( $\mu\text{m}$ )
TITANIUM BEADS (TB)				
TB	5 7	13 $\pm$ 1	23	15 $\pm$ 3
TB-PSS(-)	9 2	11 $\pm$ 1	22	116 $\pm$ 9
TB-PGA(-)	4 3	10 $\pm$ 1	19	160 $\pm$ 12
TB-PLL(+)	6 9	17 $\pm$ 2	0	0

Mean $\pm$ standard errors are given from five to ten fields for the calculations in each

group. n: number of cells. TB-PGA(-) and TB-PSS(-) groups have been compared to TB-PLL(+) group using Dunett's Method. TB-PGA(-) and TB-PSS(-) groups differ significantly ( $p < 0.001$ ) from TB-PLL(+) group.

⇒ test modèle de traction longitudinale dans une direction suivie sous ESEM

