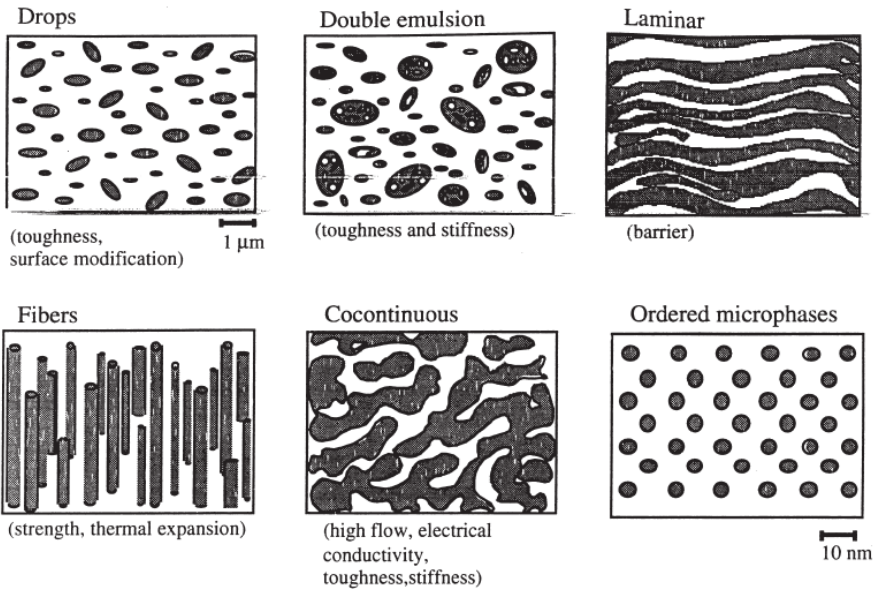


# Layer breakup in multilayered PC/ABS blends: causes and consequences

Xavier Mackré, Valentin Barandard, Bruno Fayolle, Matthieu  
Gervais, Cyrille Sollogoub

# Context

## Blend morphology



Macosko, C. W. (2000)

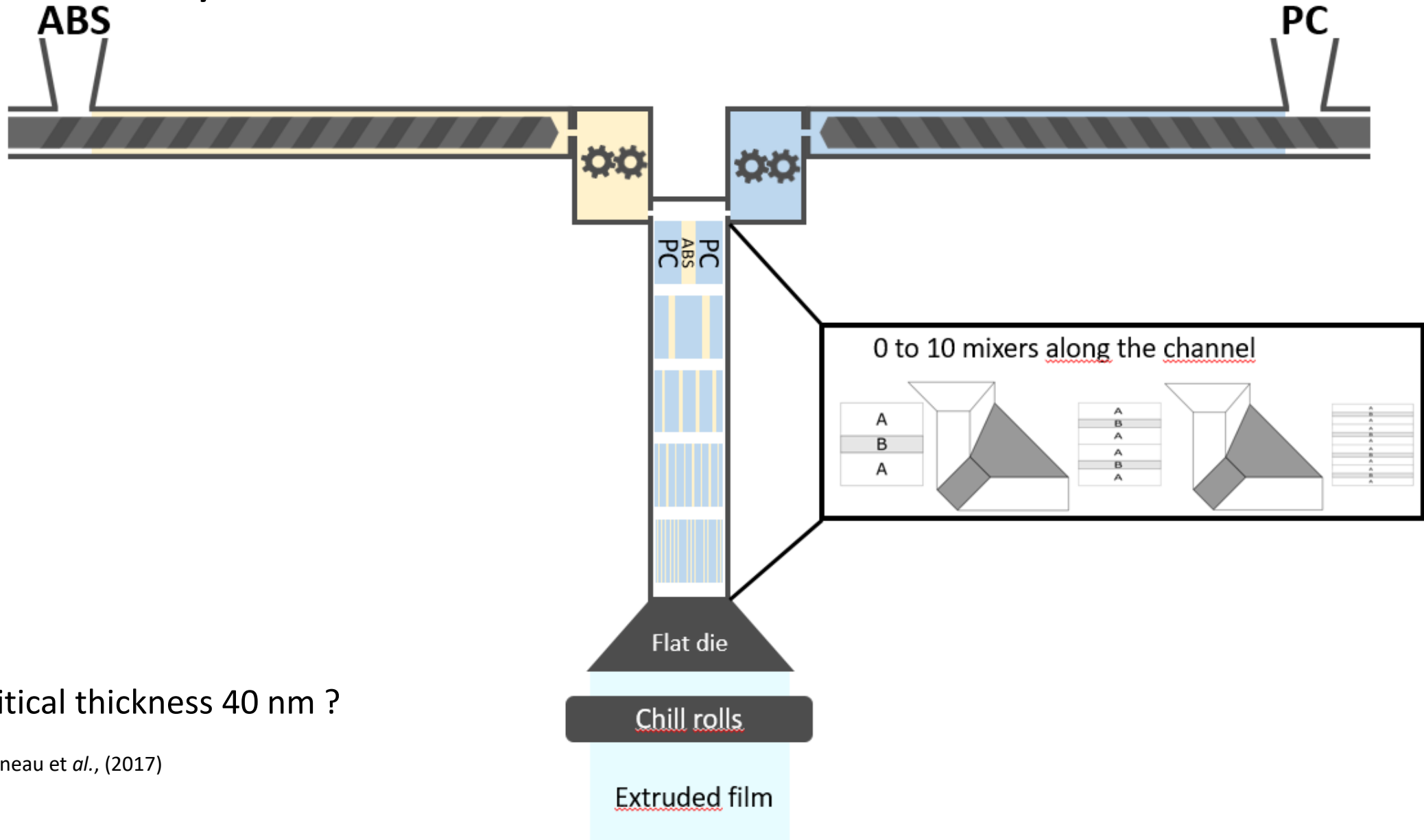
## Multilayer coextrusion

- Mainly used in packaging
- Increased barrier properties
- Modifying deformation behavior
- Increasing mechanical properties

Carr J. M (2012)

Yang, S. (2015)

# Multilayer coextrusion

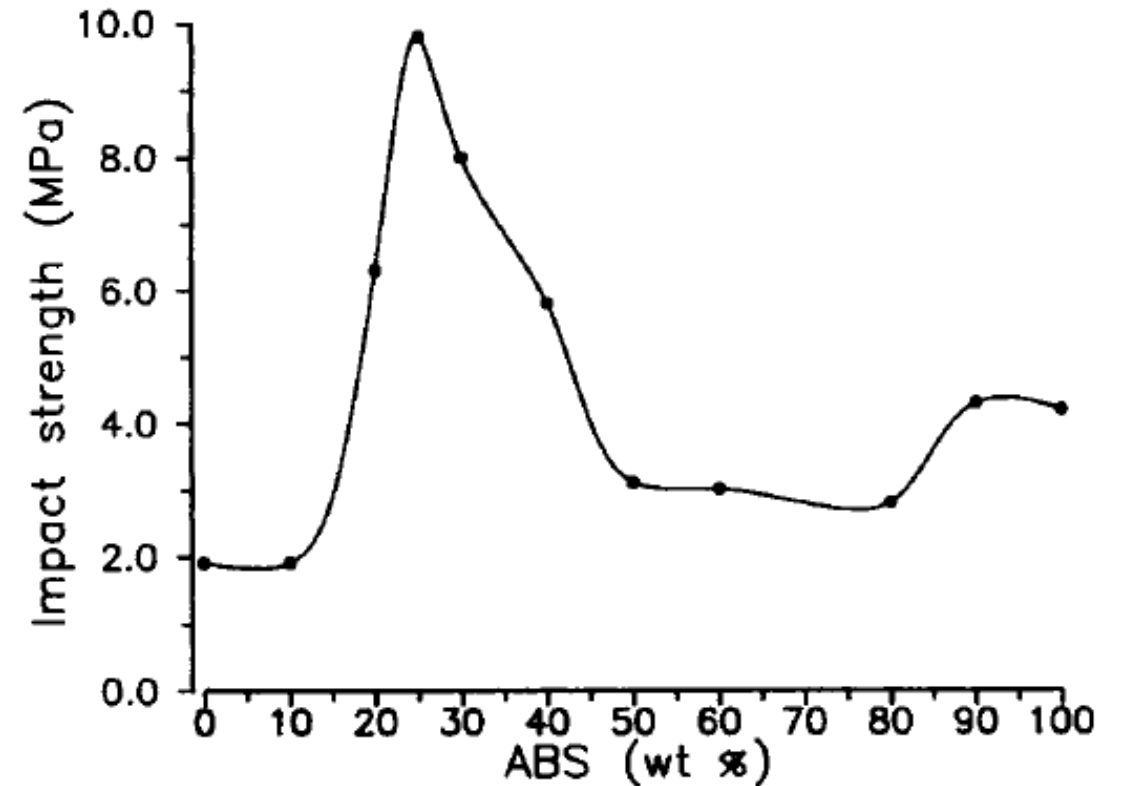


Critical thickness 40 nm ?

Bironeau et al., (2017)

# Why PC/ABS?

- PC/ABS exists as a commercial blend
- Common plastics in WEEE
- Complementary properties
- Compatibility
- Synergy for specific composition



Impact strength as a function of wt% of ABS in PC

R. Greco *et al.*, 1994

R. Krache *et al.*, 2011

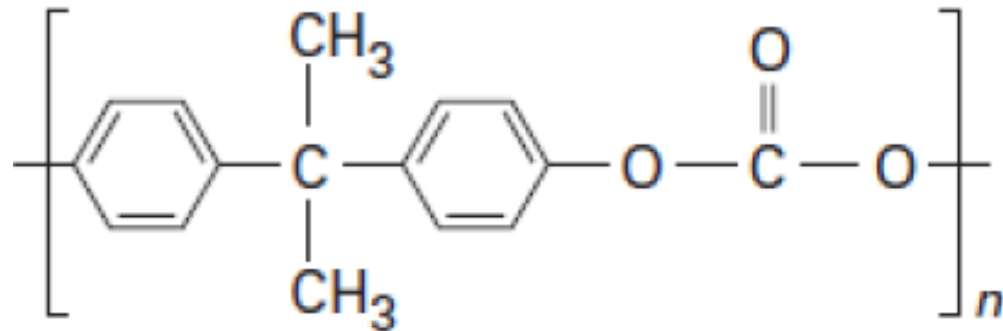
Z. Y. Tan *et al.*, 2006

H.-T. Chiu *et al.*, 2018

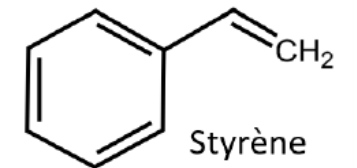
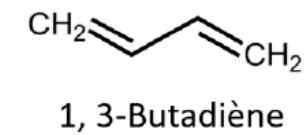
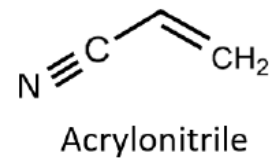
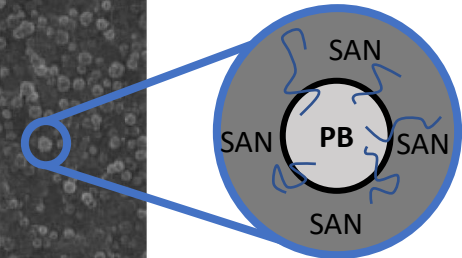
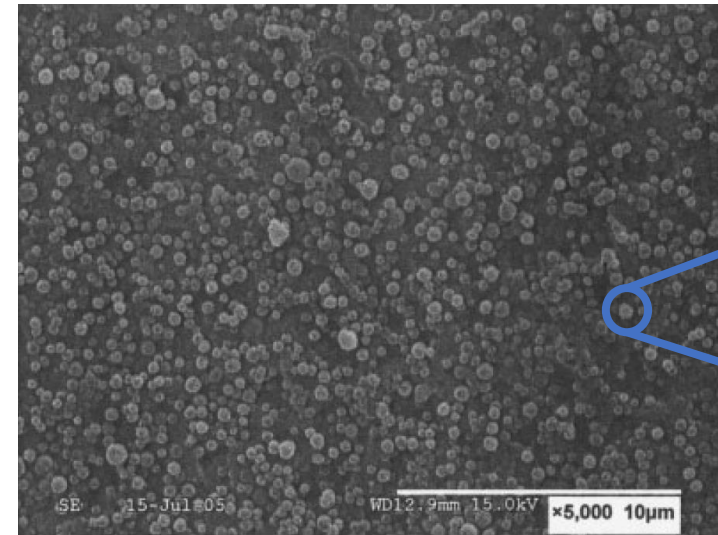
# Materials used

## PC Calibre 201-22 (Trinseo)

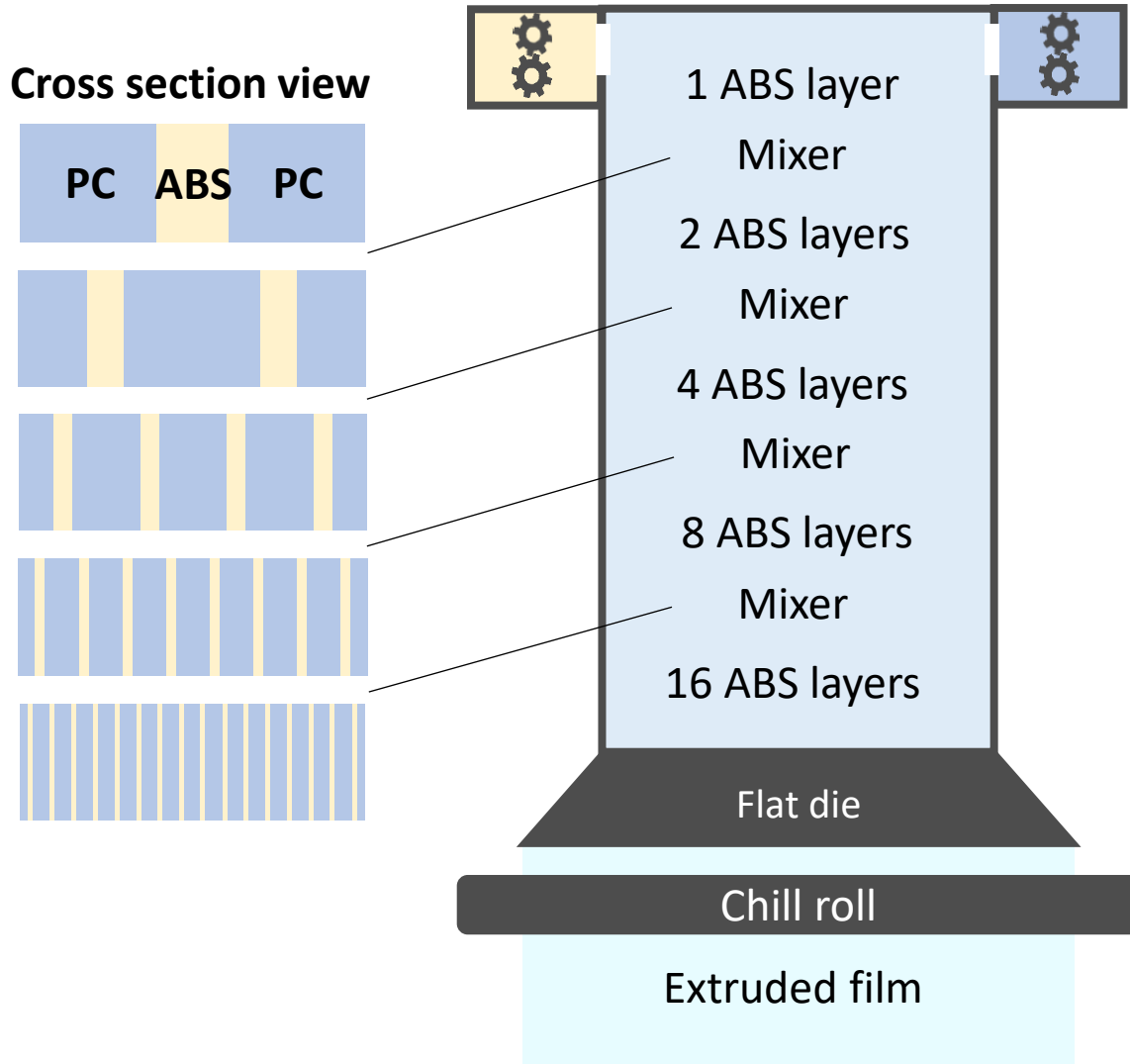
- Matrix polymer (80 wt%)



## ABS HF 380 (LG Chem)



# Multilayer coextrusion, zoom on process



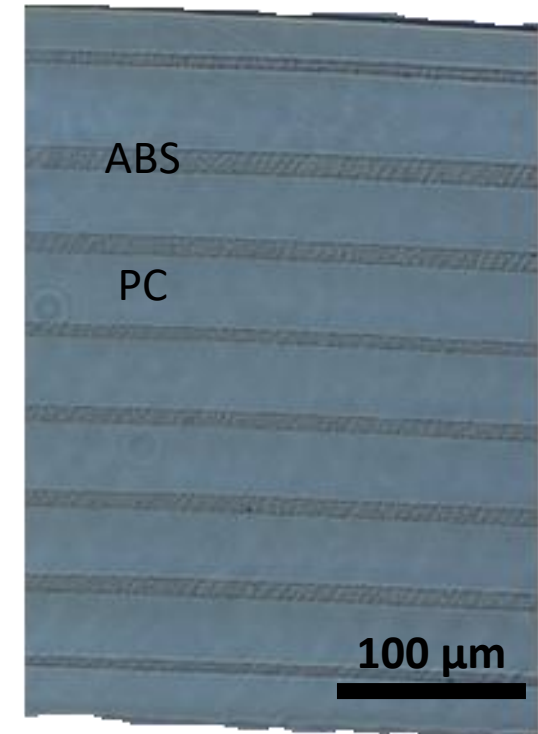
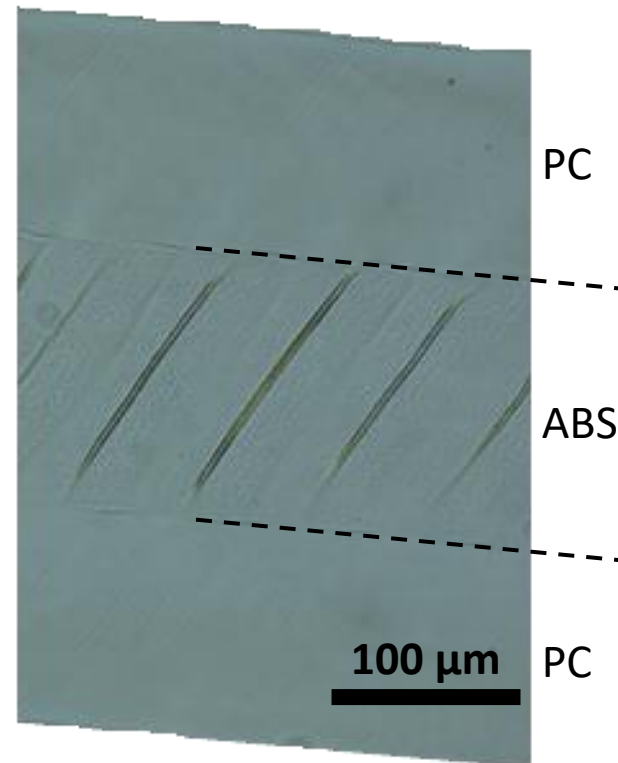
- PC/ABS, 80/20 wt%
- Overall thickness 50 to 400  $\mu\text{m}$
- 0, 3, 5, 6, 8, 9 or 10 static mixers ( $n$ )
- $N_{\text{Layers of ABS}} = 2^n$
- $N_{\text{Total layers}} = 2^{n+1} + 1$

# Observing layers

## Method

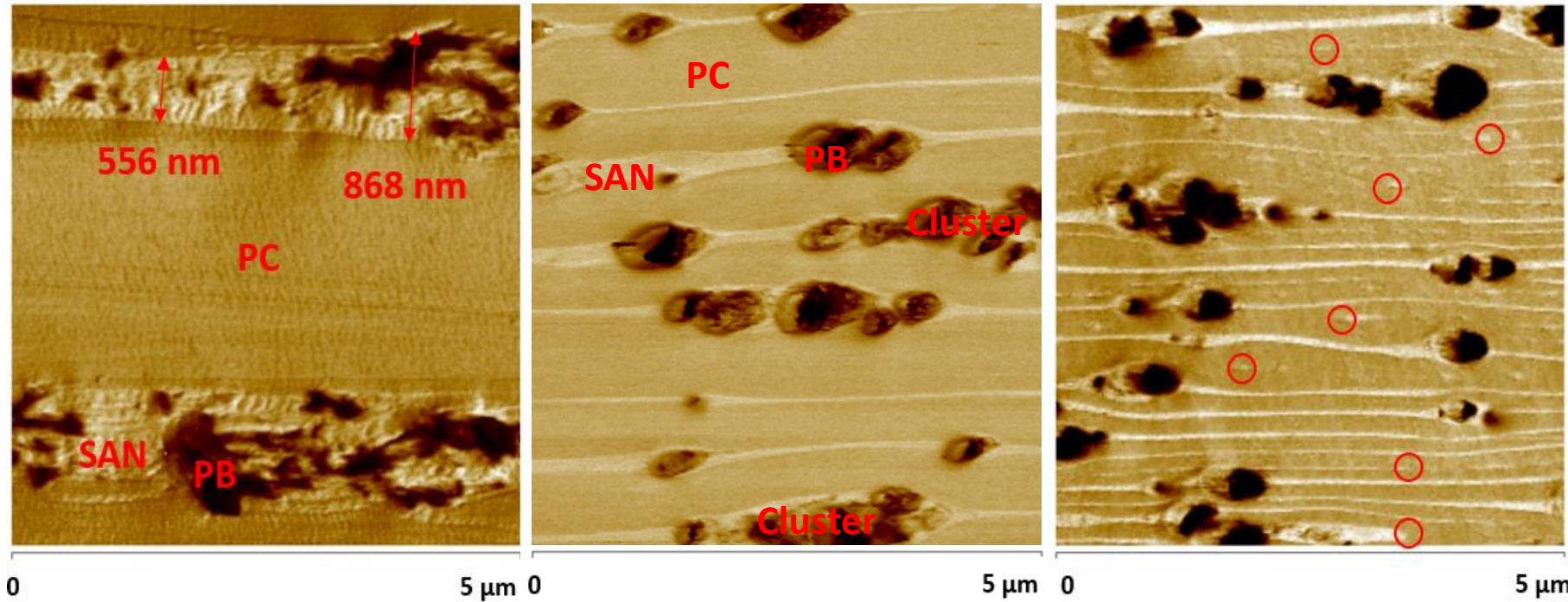
- Film cut by microtome
- Optical cross section image
- Nanometric scale:
  - Cutting with diamond knife
  - AFM images of the samples
  - Peakforce QNM

## Optical cross section image of films with no multiplier and 3 multipliers





# AFM monitoring of morphology



- Layer distortion (<800 nm)
- Agglomeration of nodules
- Layer breakup for thin layers (<140 nm)

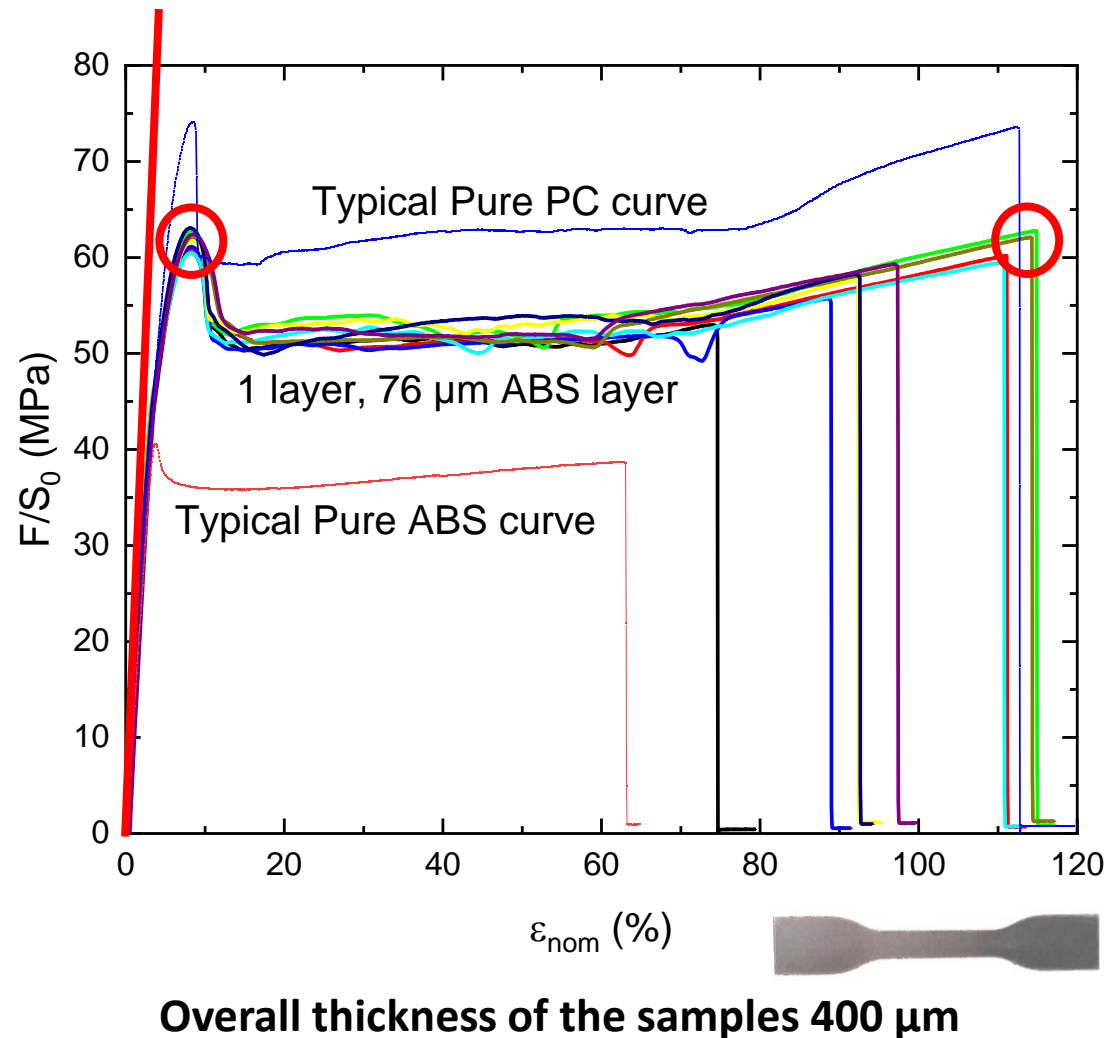
32 layers  
Nominal thickness 555 nm,  
Measured 670 nm ( $\pm 160$ )

256 layers  
Nominal thickness 140 nm,  
Measured 88 nm ( $\pm 62$ )

512 layers  
Nominal thickness 35 nm,  
Measured 28 nm ( $\pm 18$ )

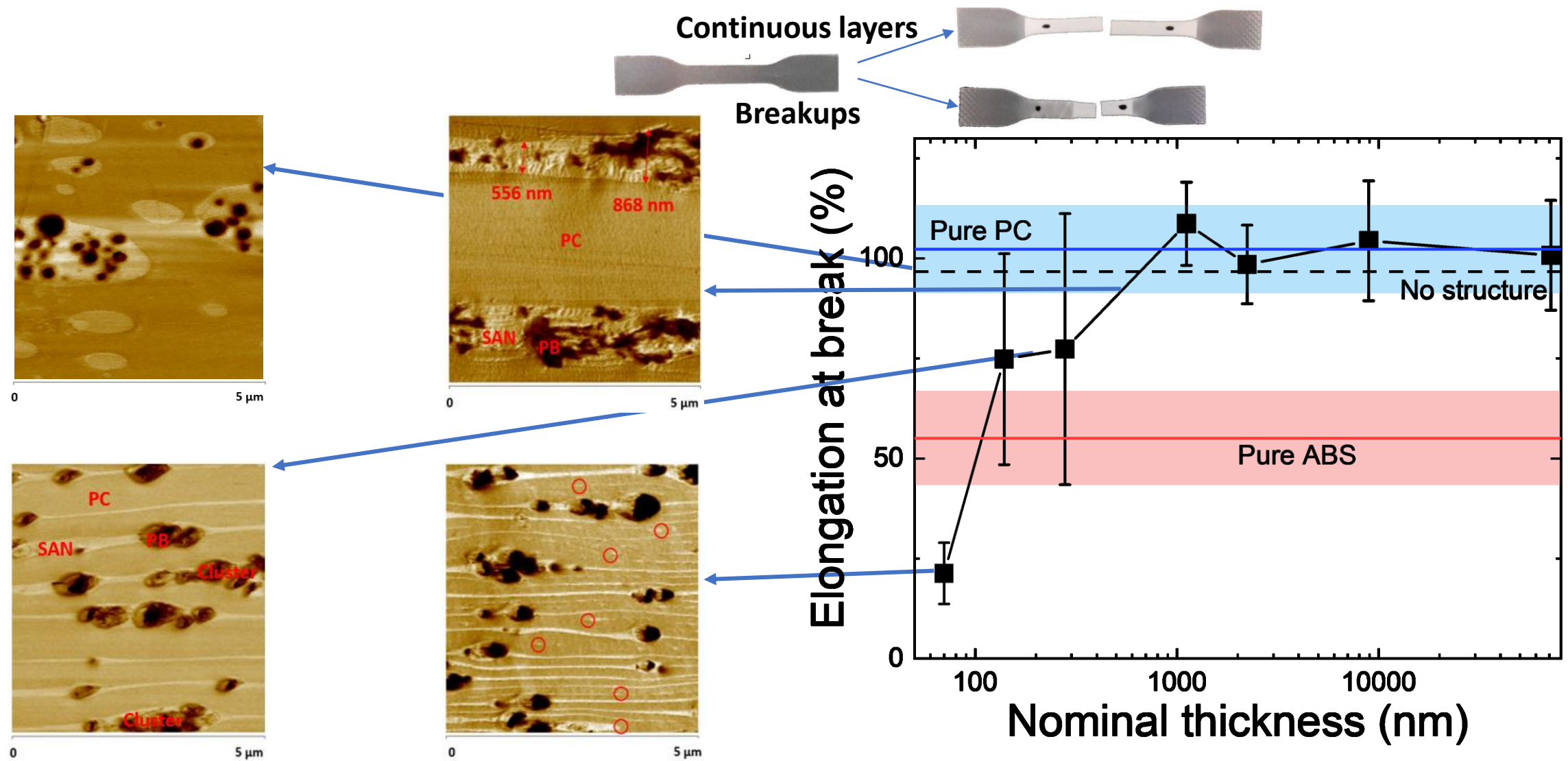


# Tensile test :methode



- Instron 5996 pneumatic grips, 10kN load cell
- Speed 10 mm/min
- 20 mm by 4 mm dogbone
- 10 samples are tested for each parameter
- Modulus
- Stress/strain at yield and break

# Layer breakup and $\epsilon_{\text{break}}$



# Conclusion/perspectives

## Results

- Successful structuration of PC/ABS
- Layer distortion by PB phase (thickness lower than 800 nm)
- Breakup (thickness lower than 140nm)
- Loss in  $\epsilon_{\text{break}}$

## Perspectives

- Impact testing
- Injection or thermoforming

# Thank you for your attention!

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Chaire  
Mines Urbaines