# Microstructure, Barrier Properties, and Mechanical Properties of Nylon-12 Nanocomposite Films

by

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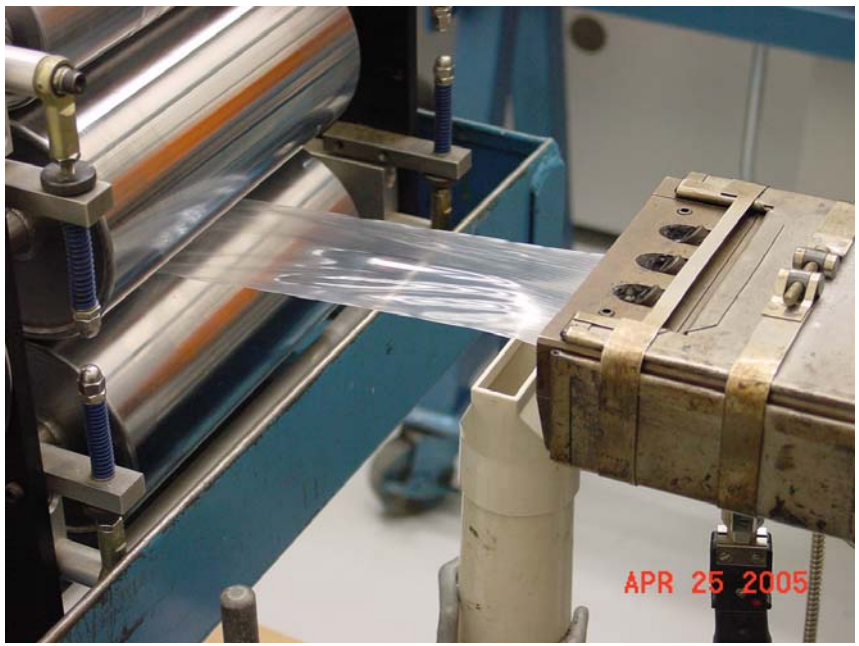
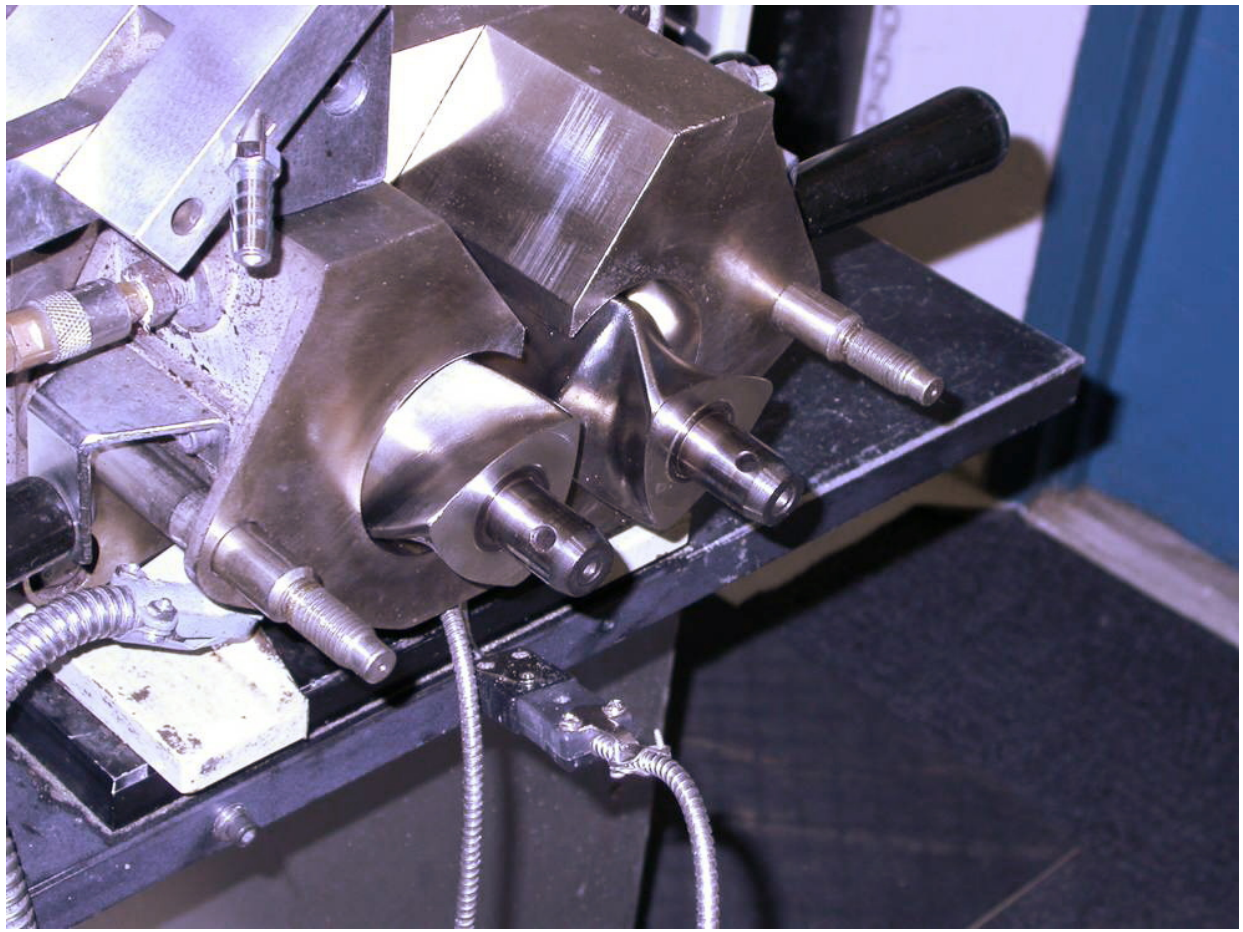
# Samples

- Extruded films
- 1.0 mil thick
- 10% treated montmorillonite clay in nylon-12
- Various blending methods

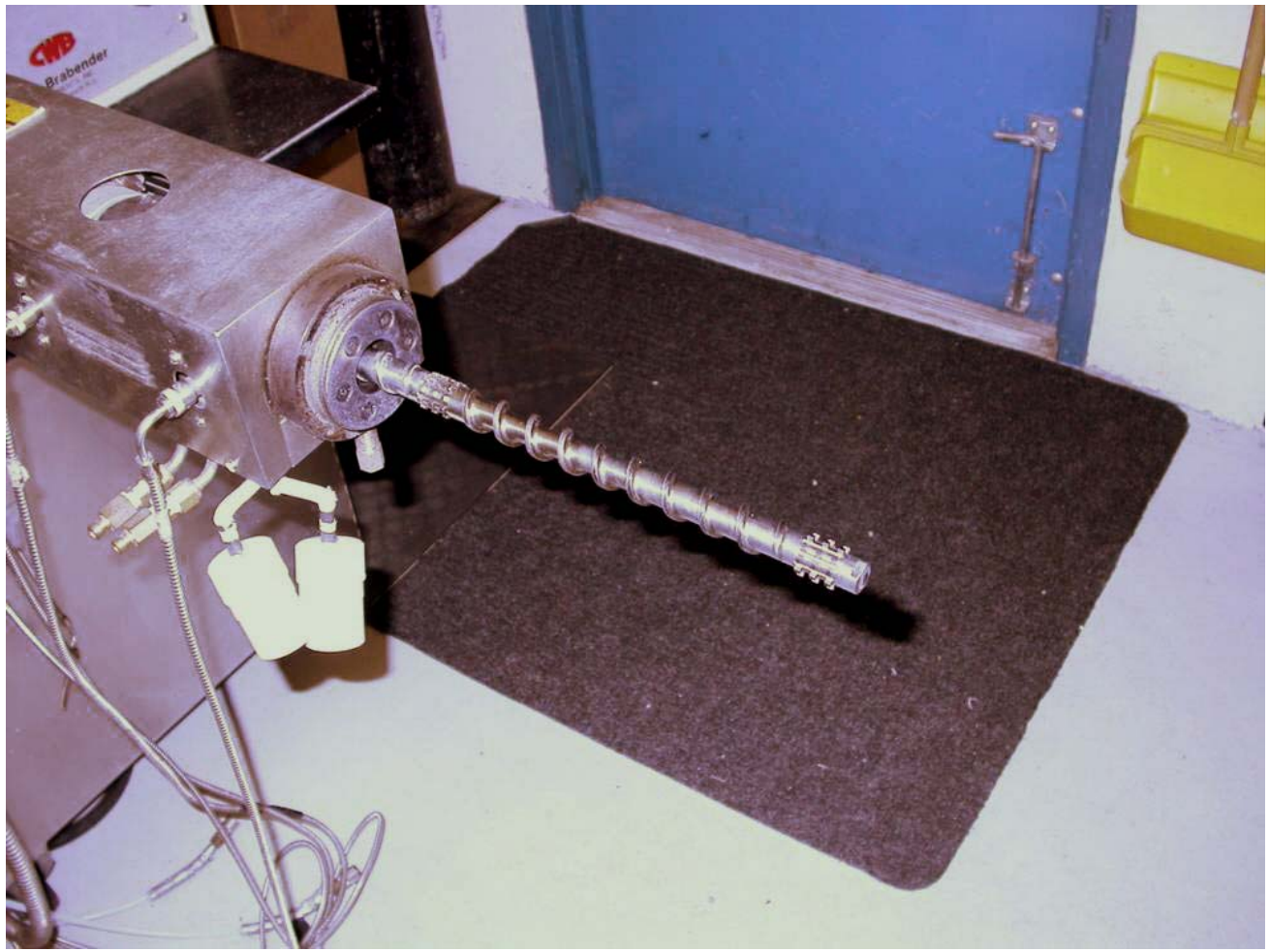


# Batch blending for 1 minute (B)



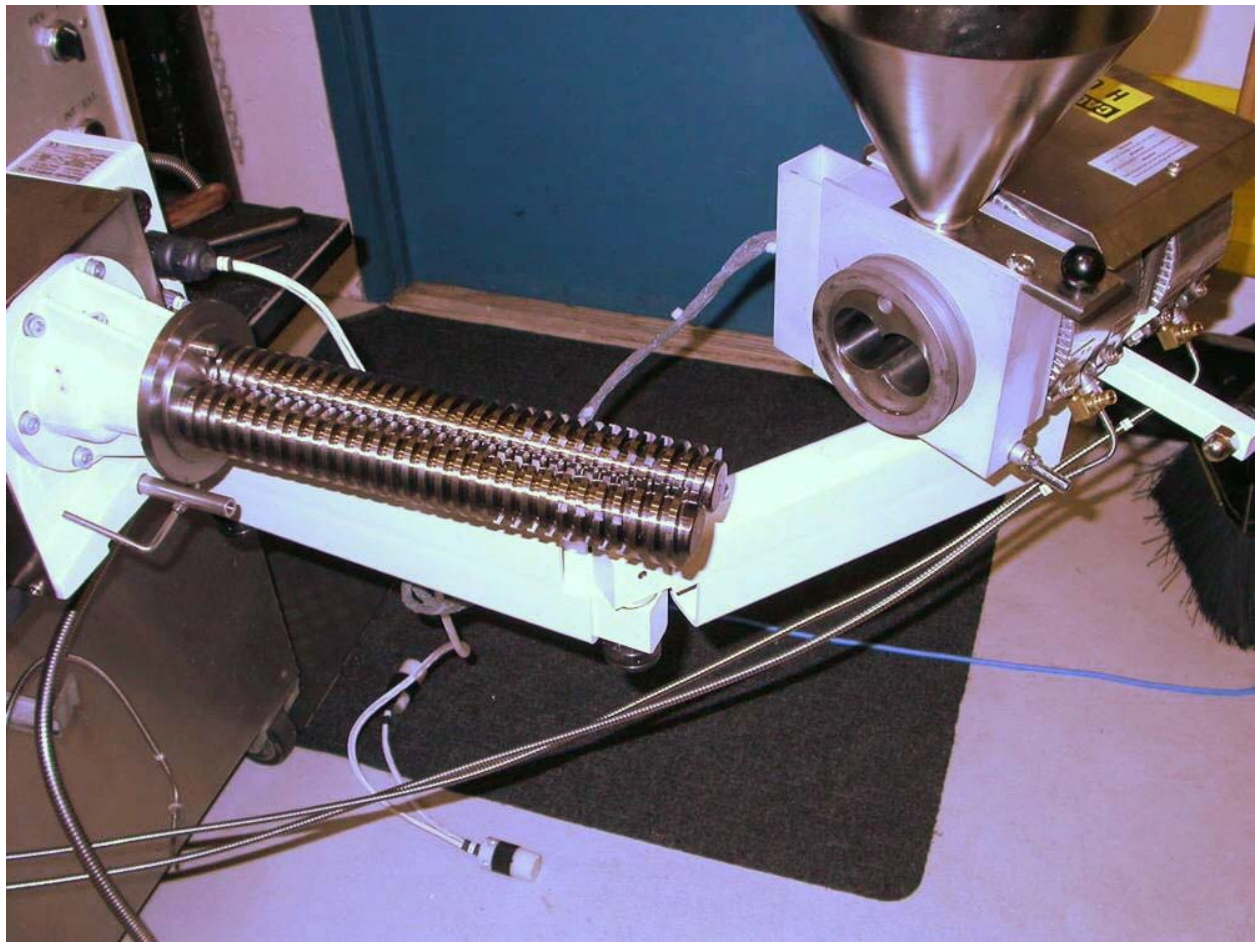
REE 67 prep mixer with high-shear roller blades (W.C. Brabender)

# Single-screw extrusion (C)



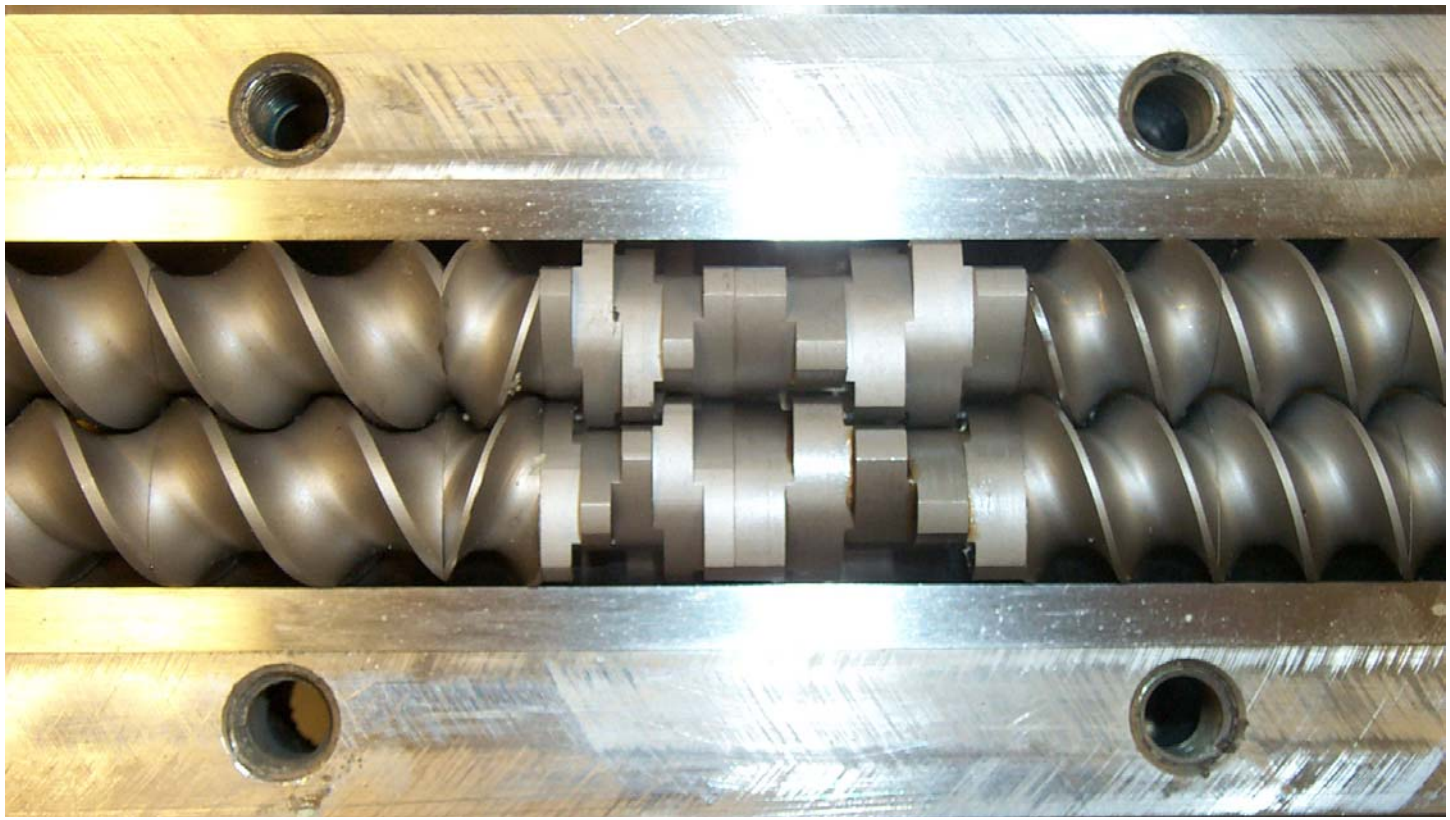

25mm extruder with mixing screw, L/D = 25 (W.C. Brabender)

# Twin-screw extrusion with compounding screws (D)



D6-2 counter-rotating twin-screw extruder, L/D = 6 (W.C. Brabender)

# Twin-screw extrusion with standard screws (E)



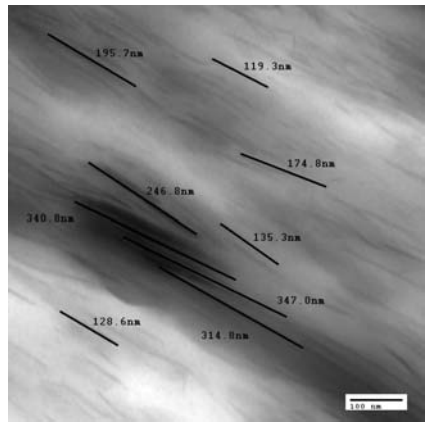
TSE 20mm co-rotating twin-screw extruder, L/D = 40 (W.C. Brabender)

# Methods of Assessment

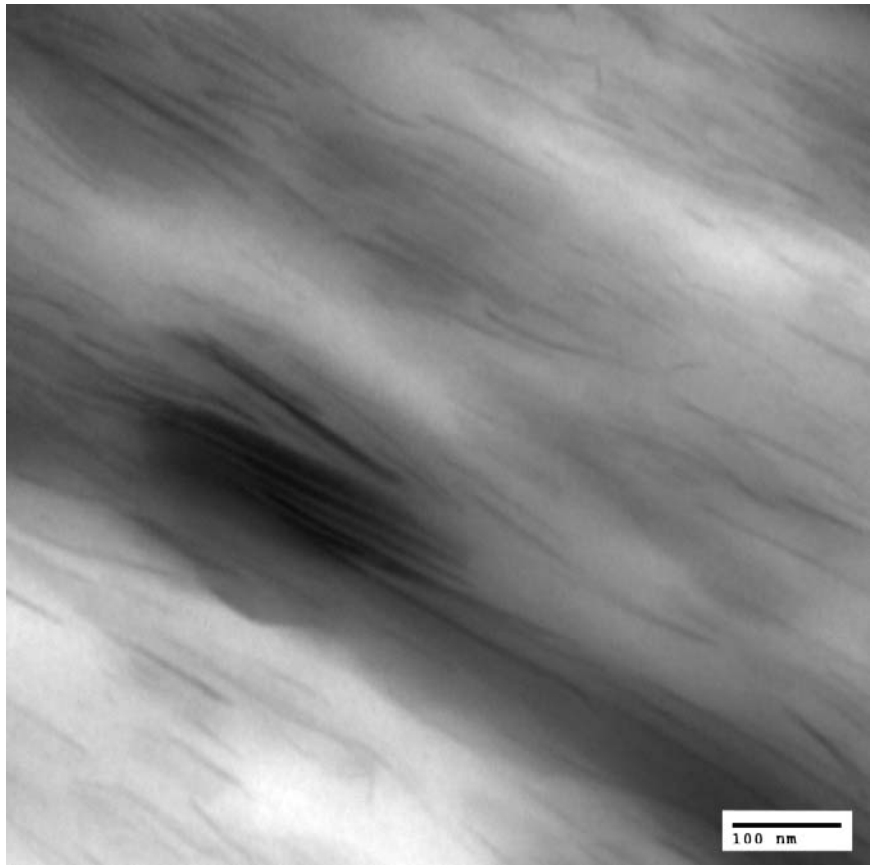
- Physical
  - Mechanical properties
    - Stress
    - Strain
    - Young's modulus
  - Barrier properties
    - Breakthrough time
- Structural
  - TEM imaging
    - Platelet size
    - Platelet exfoliation
  - FTIR spectroscopy

# Observed Platelet sizes (nm)

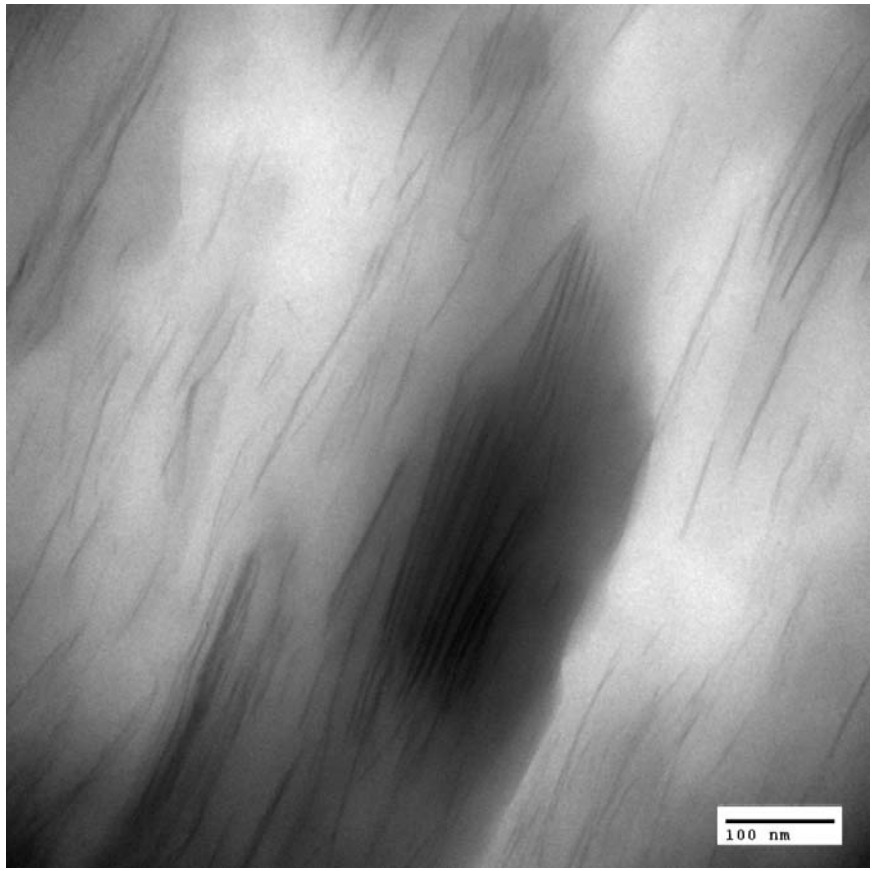
| | |
|---|---|
| A (100% nylon-12) | N/A |
| B (batch blended) | 202 |
| C (single-screw extrusion) | 171 |
| D (compounding twin-screw) | 144 |
| E (standard twin-screw) | 111 |



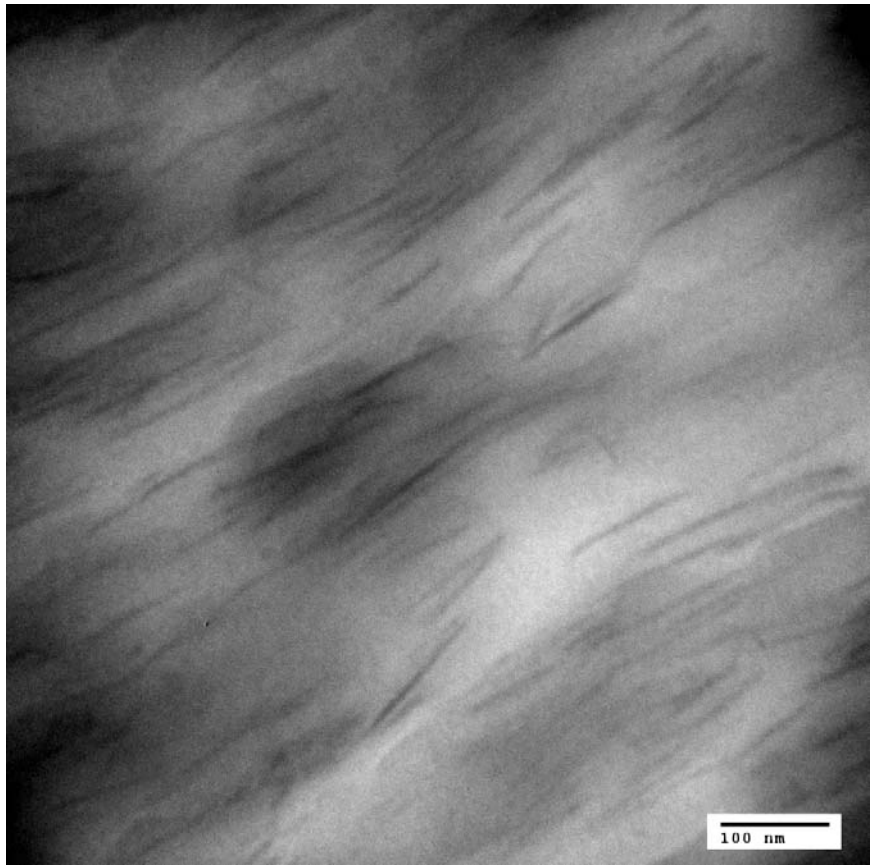
# Platelet exfoliation
# Batch blending (B)



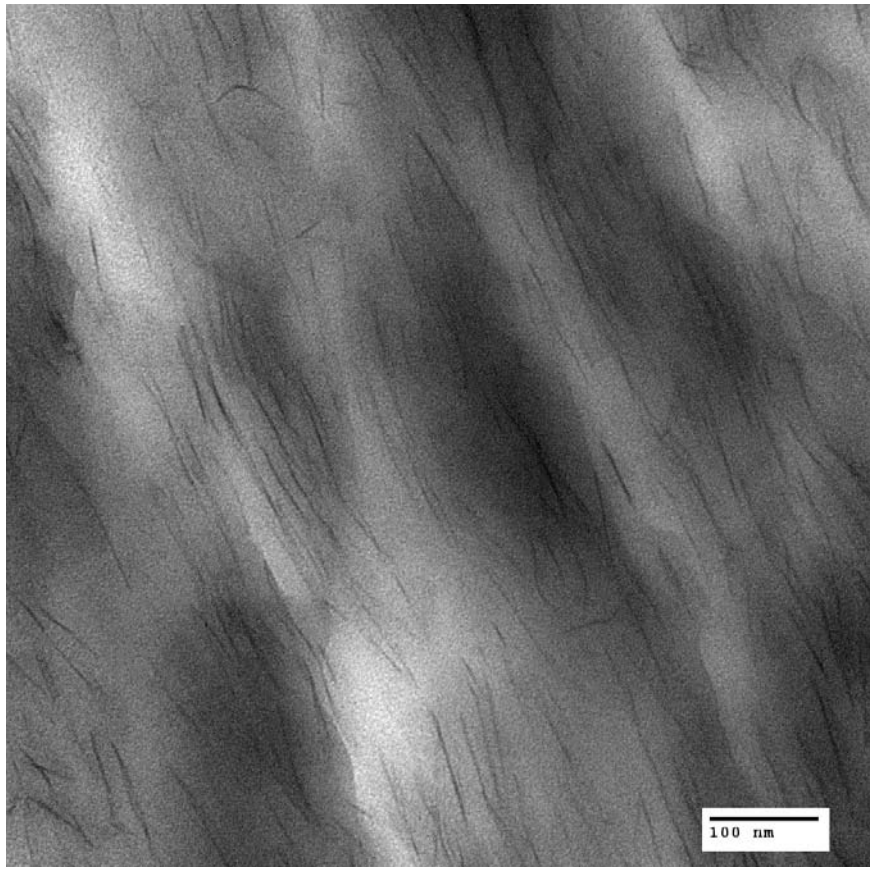
# Platelet exfoliation
# Single-screw extrusion (C)



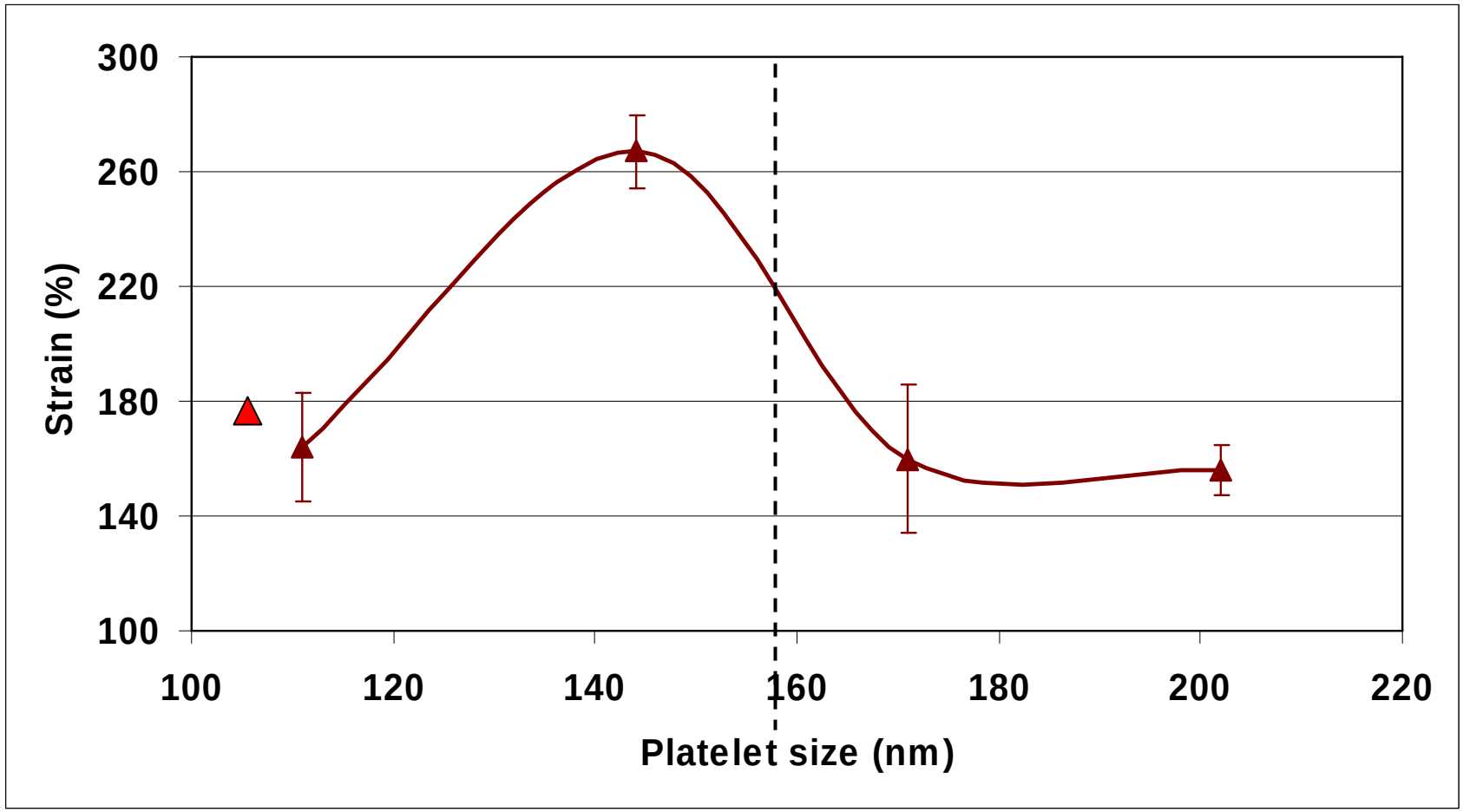
# Platelet exfoliation
# Compounding twin-screw (D)



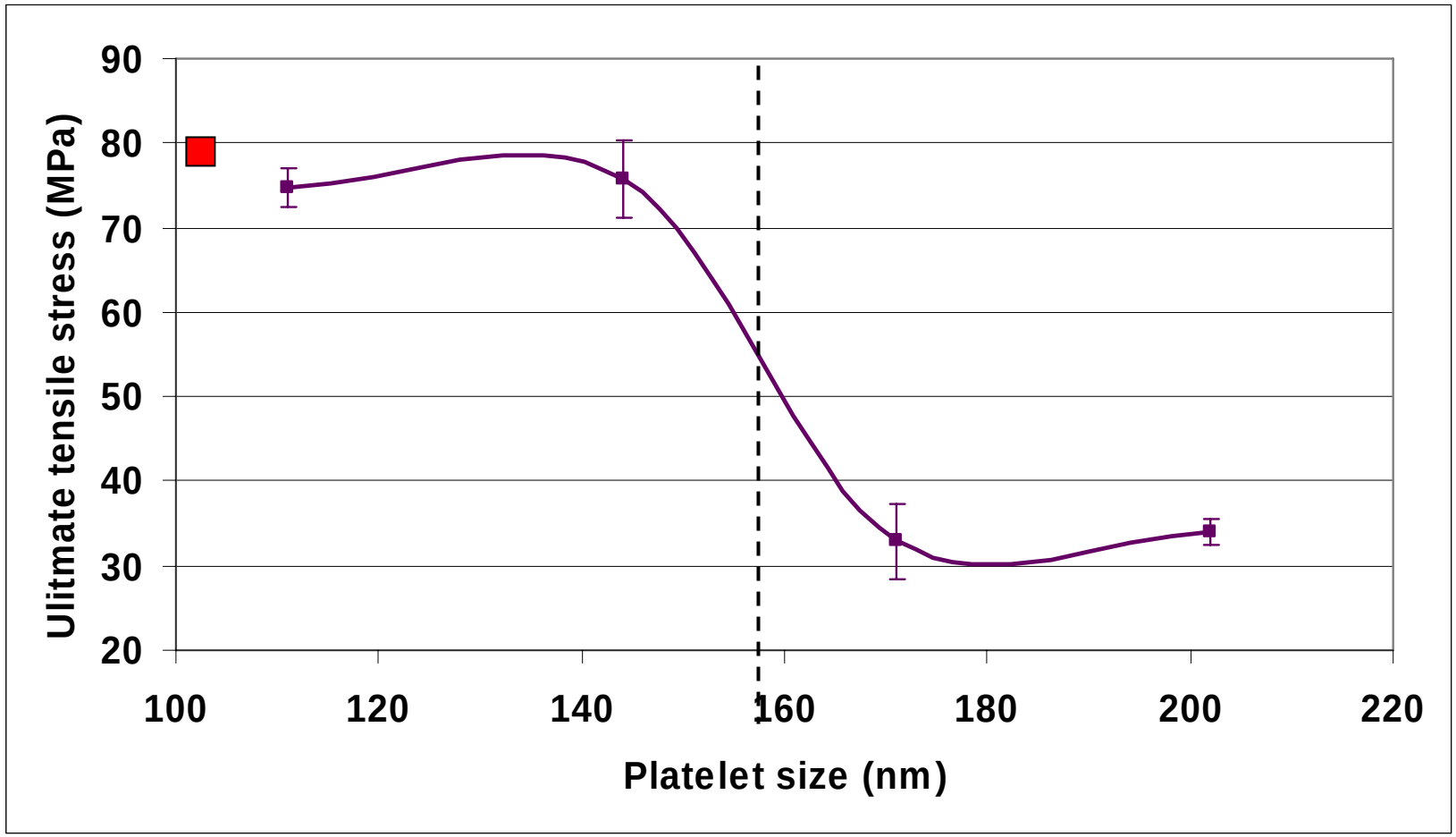
# Platelet exfoliation
# Standard twin-screw (E)



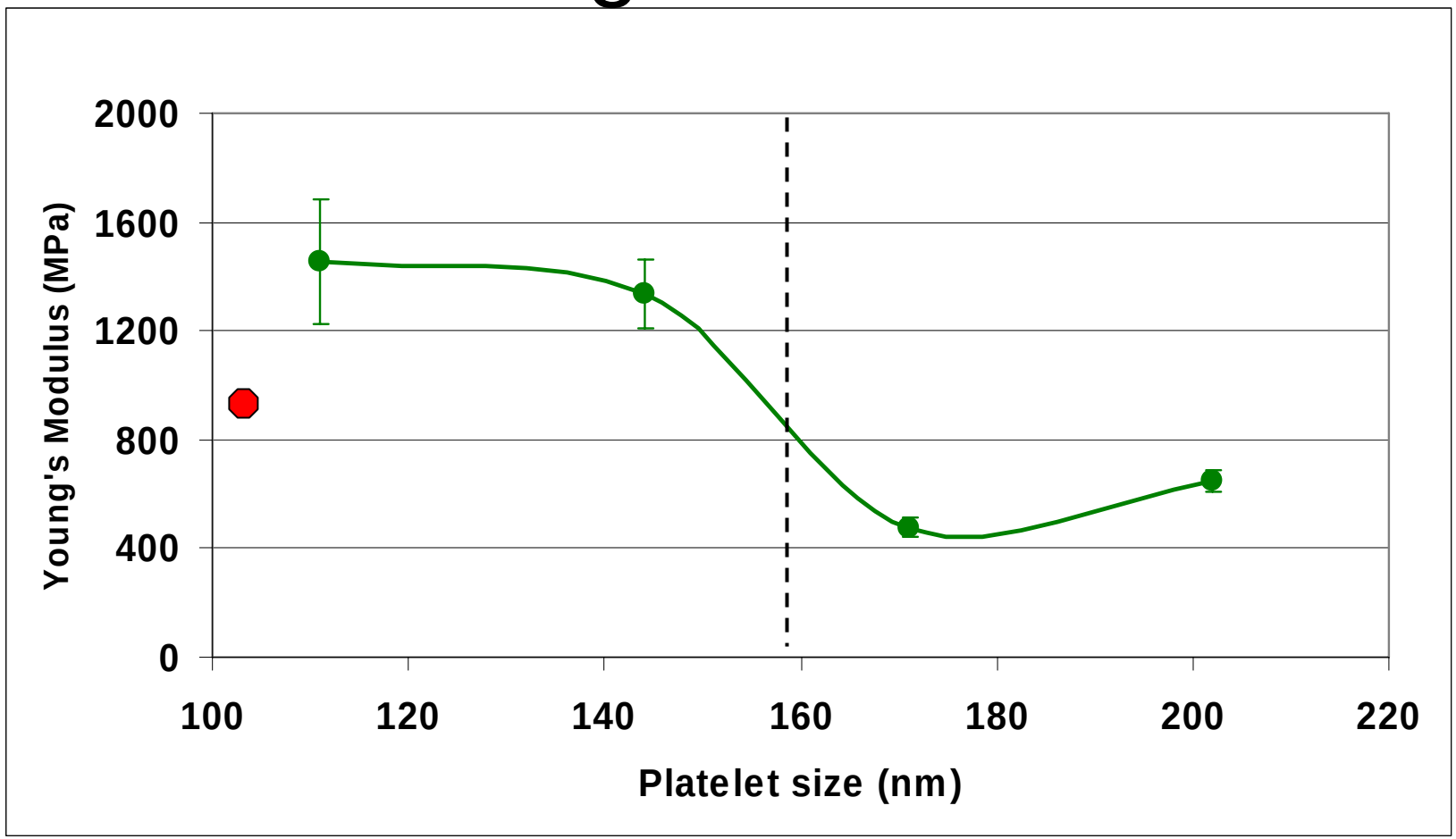
# Mechanical properties
# Strain (%)



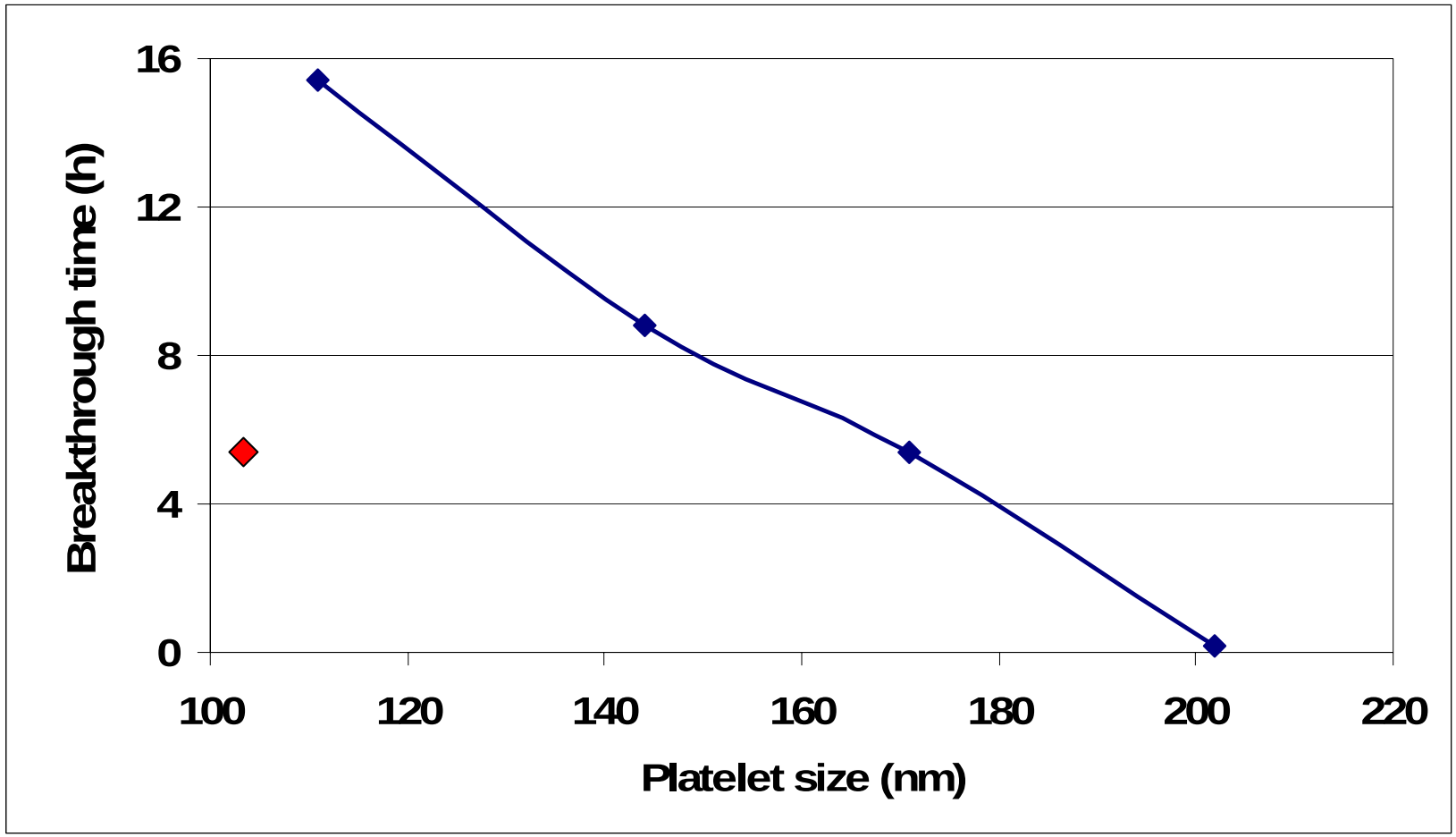
# Mechanical properties
# Ultimate tensile stress



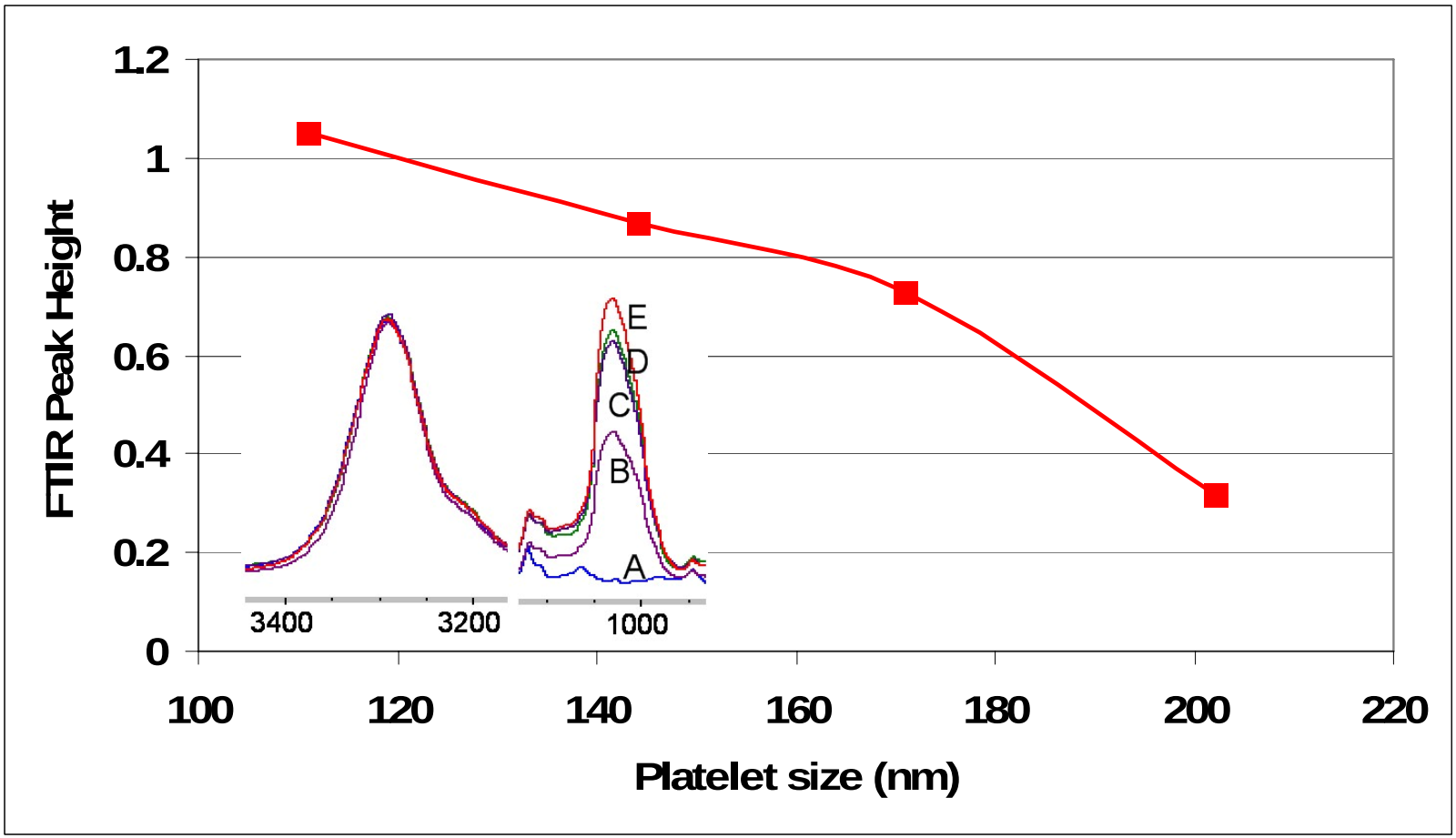
# Mechanical properties
# Young's modulus



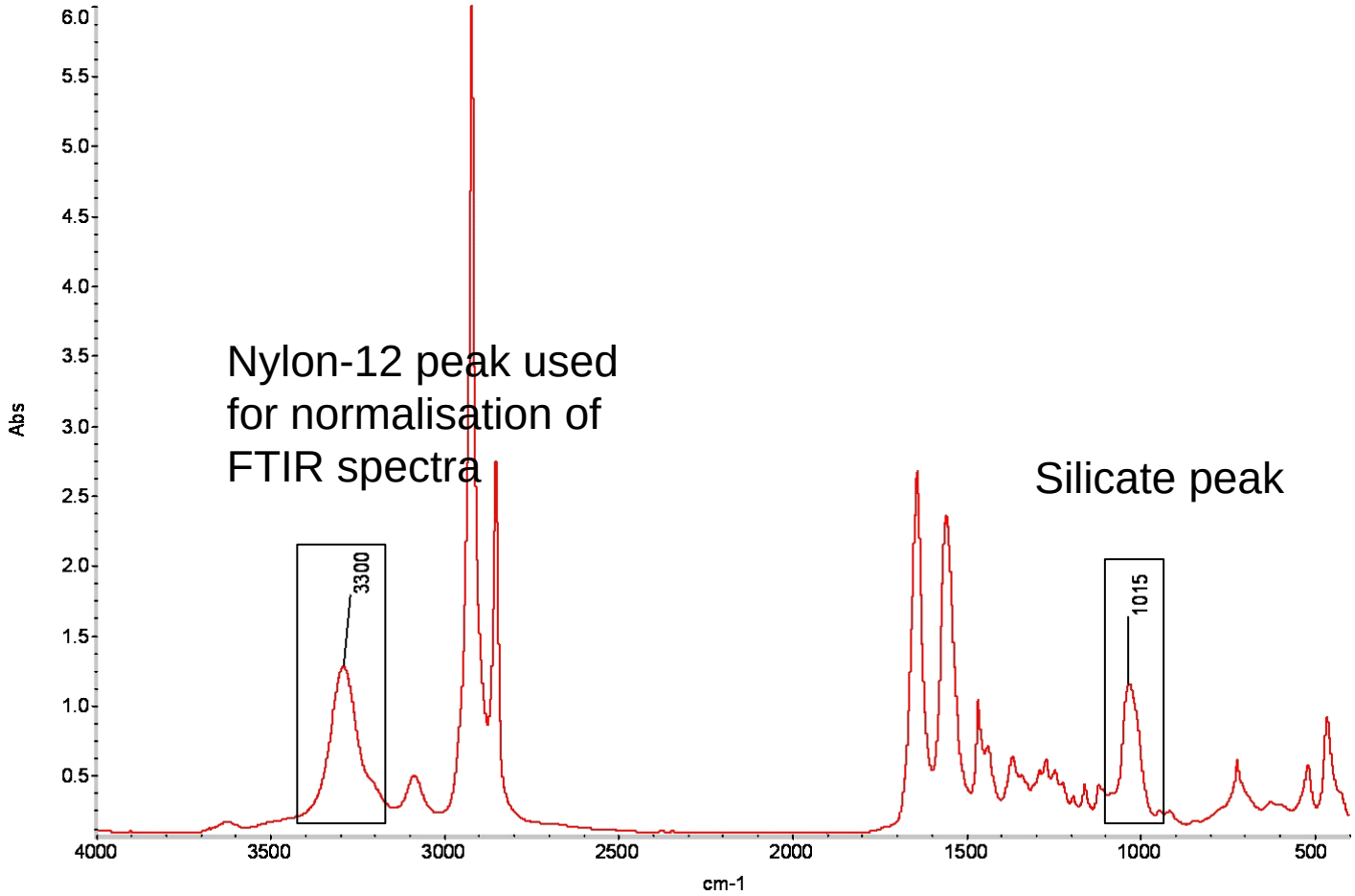
# Breakthrough time



# FTIR spectroscopy



# FTIR example spectrum



# Conclusions

- Platelet size starts to decrease prior to full exfoliation.
- Prior to full exfoliation, mechanical properties are not highly responsive to platelet size (completeness of exfoliation).
- After exfoliation, elongation at break is directly dependent on platelet size.
- After exfoliation, stress and Young's modulus are not highly responsive to platelet size, although improved over non-exfoliated samples.
- Barrier properties are inversely related to platelet size both before and after exfoliation.
- FTIR may be responsive to nanoclay dispersion.

# Acknowledgements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