MATERIALES
PARA
EL DESARROLLO SUSTENTABLE

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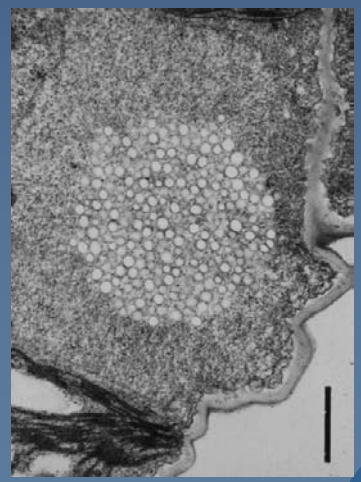
Bio Polymers or Biobased Polymers

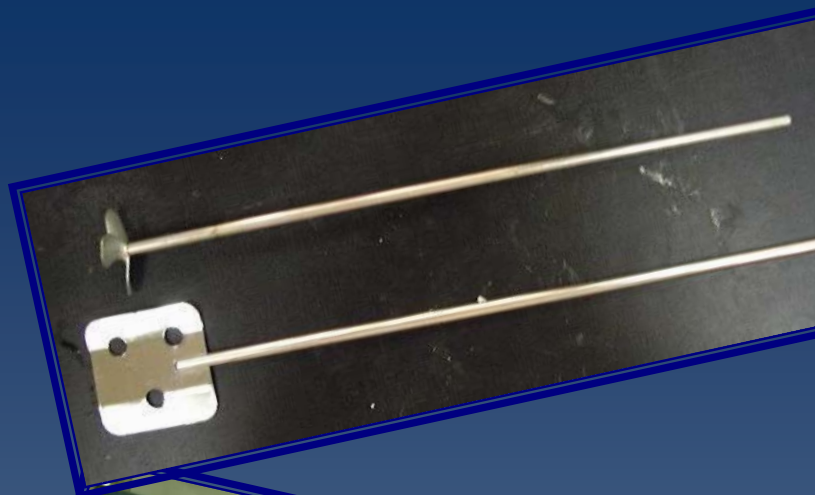
Renewable Resource-based

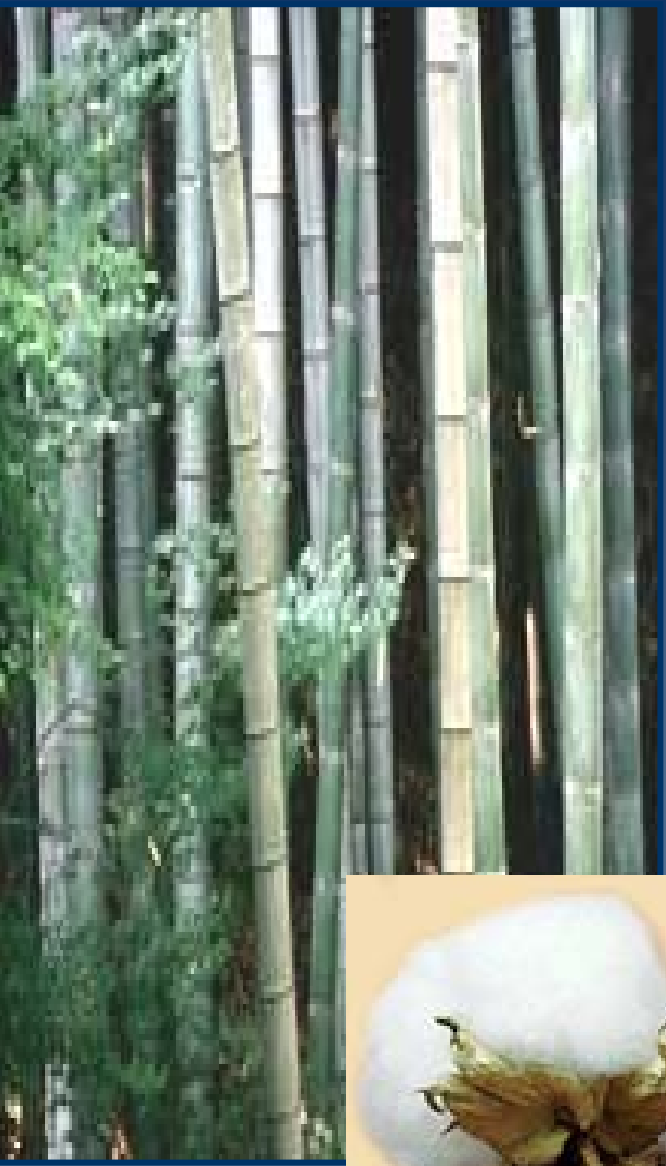
Microbial synthesized



INTI

Plasticos





COMPOSITE MATERIAL FROM COTTON SEED PROTEIN AND NATURAL FIBER

Protein Extraction from cottonseed pellets at Pilot Plant Scale (INTI-Cereales)

Pellets Production

Oil extraction (VICENTIN)

- Pressing (90°C)
- Hexane extraction (60 °C)
- Solvent elimination (90°C)
- Granulation (pellets)

SDP

Water

30 min, 30 °C
500 rpm
pH = 10 ,TEA

Plastizacer

15 min
30 °C
500 rpm

Crosslinking agent

15 min
30 °C
500 rpm

Degasification

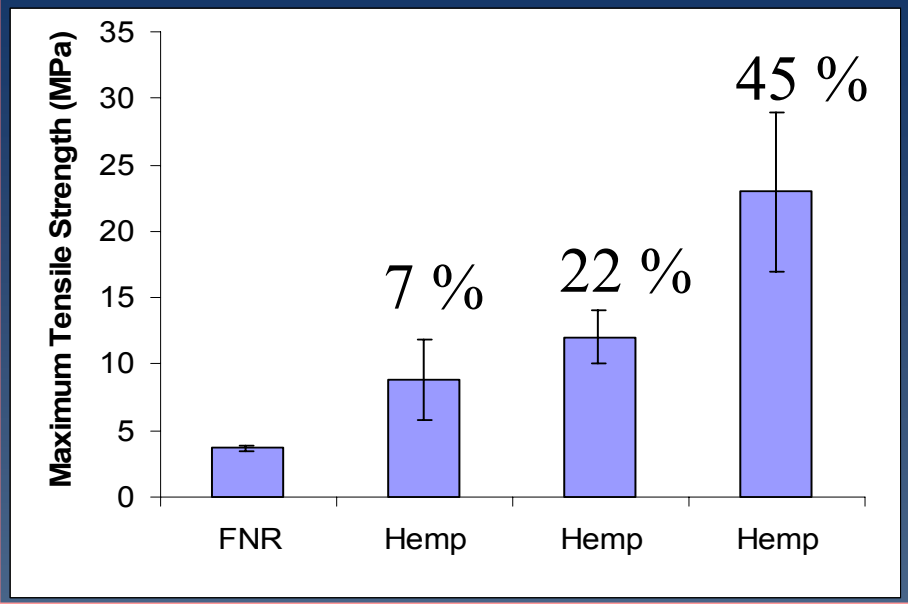
Filmogenic Solution

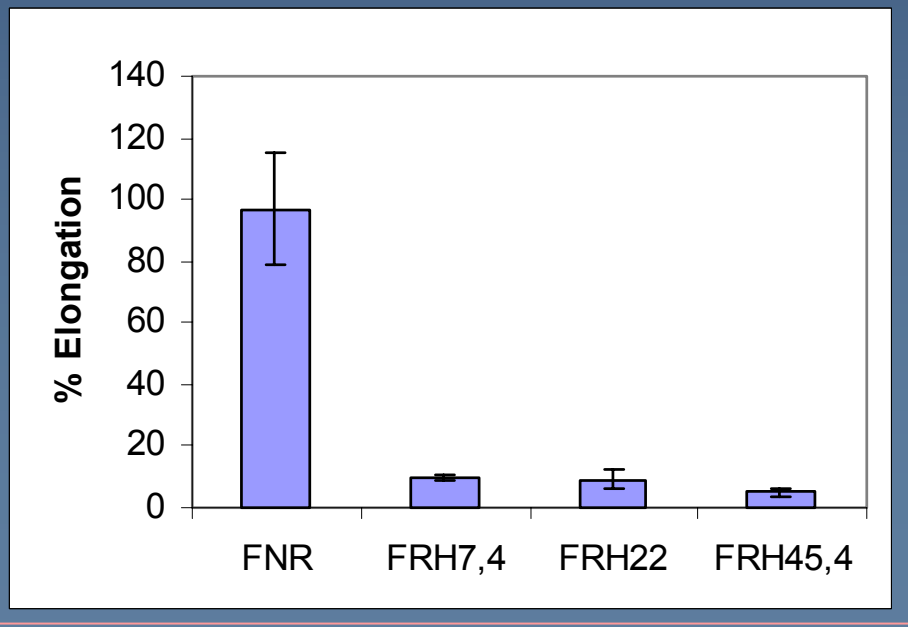
Reinforced Formie Films Mecanical Properties

18 % fiber content
produce ~ 460% increase
in MTS
& 93% in % elongation lost

36% fiber content
produce ~ 750 % increase
in MTS
& 96% in % elongation lost

Reinforced Hemp Films Mecanical Properties



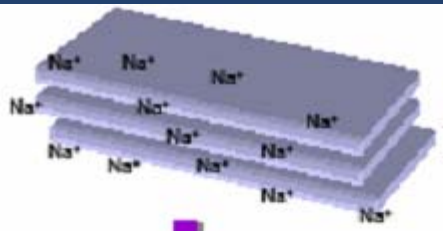


45% fiber content
produce ~ 621% increase in MTS
& 95% in % elongation lost

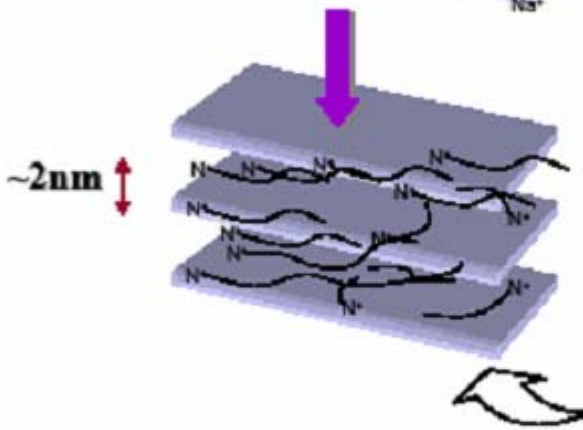
22% fiber content
produce ~ 320% increase in MTS
& 91% in % elongation lost

7% fiber content
produce ~ 240% increase in MTS
& 90% in % elongation lost

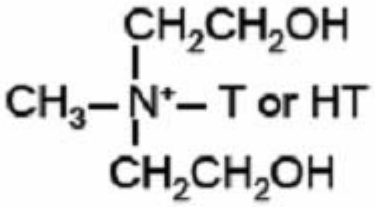
Nanocomposites are a new class of materials filled with nanometers size mineral particles instead of conventional scale fillers



Na^+-Montmorillonite + Modification with ammonium cation



Modified organophilic MMT



Where T is Tallow (~65% C18; ~30% C16; ~5% C14)

Onium ion modification

bis(2-hydroxyethyl)methyl Hydrogenated Tallow Ammonium

Source: http://www.nanocor.com/

Source: http://www.nanoclay.com/data/30B.htm

Wheat Gluten Protein - Montmorillonite Nanocomposite (MMT-Na+)

	Tensile Strength (MPa)	% Strain at Break	Young Modulus (MPa)
SC gluten O % MMT-Na+	6.8 ± 1.5[a]	63 (20)	442 (114)
SC gluten 5% MMT-Na+	10.6 ± 0.8[b]	45.4 (6)	617 (116)

left: 0 % MMT-Na+;
right: 5% MMT-Na+;

Water Vapour Permeability (WVP at 50% RH)

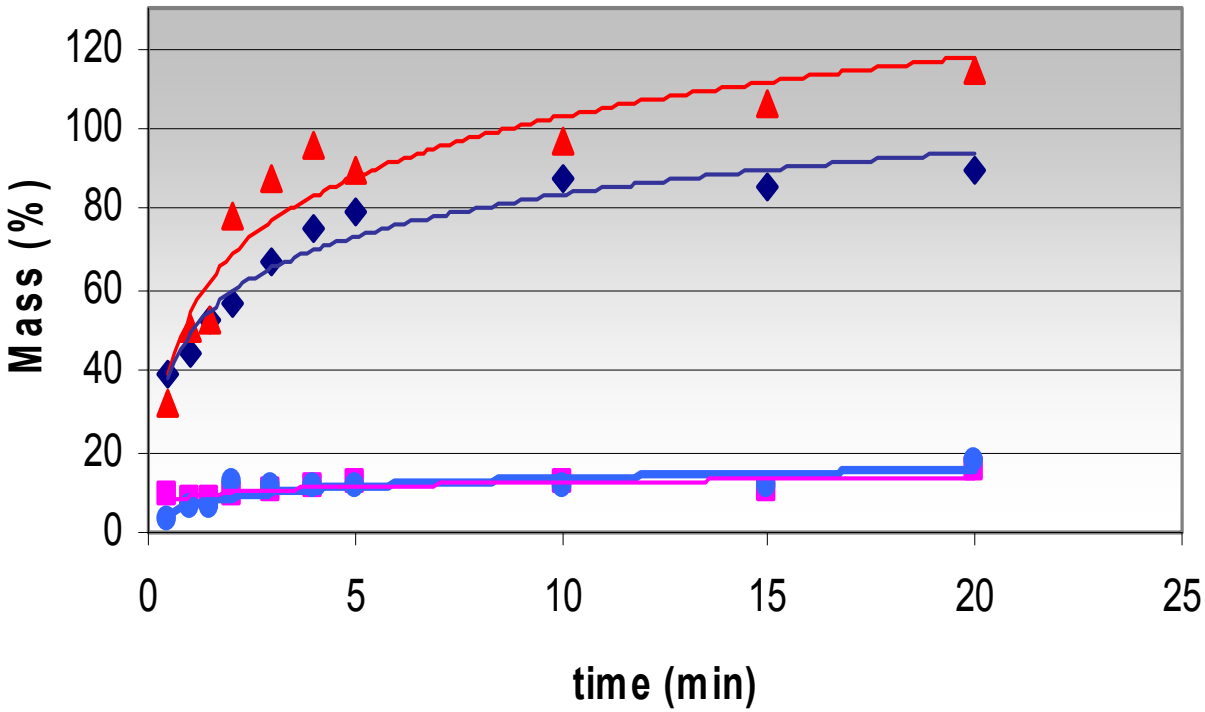
	Thickness (μm)	WVT (g/s*m*Pa)
SC gluten O % MMT-Na+	188	3,75E-11
SC gluten 5% MMT-Na+	184	1,72E-11

Nanocomposite Guten /Montmorillonite- Na+ present

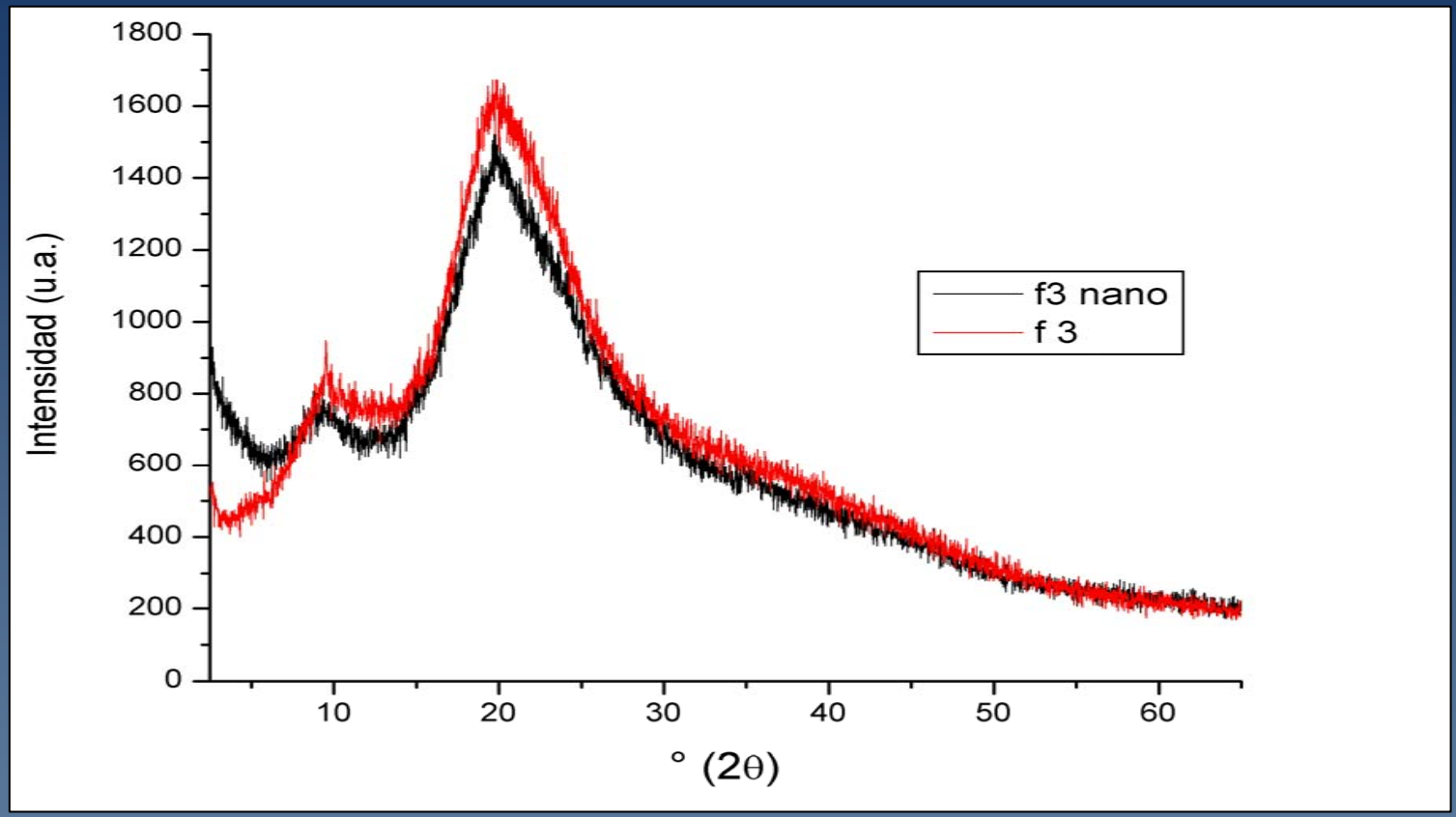
56 % increase in TS

54% reduction in WVT

Water up take

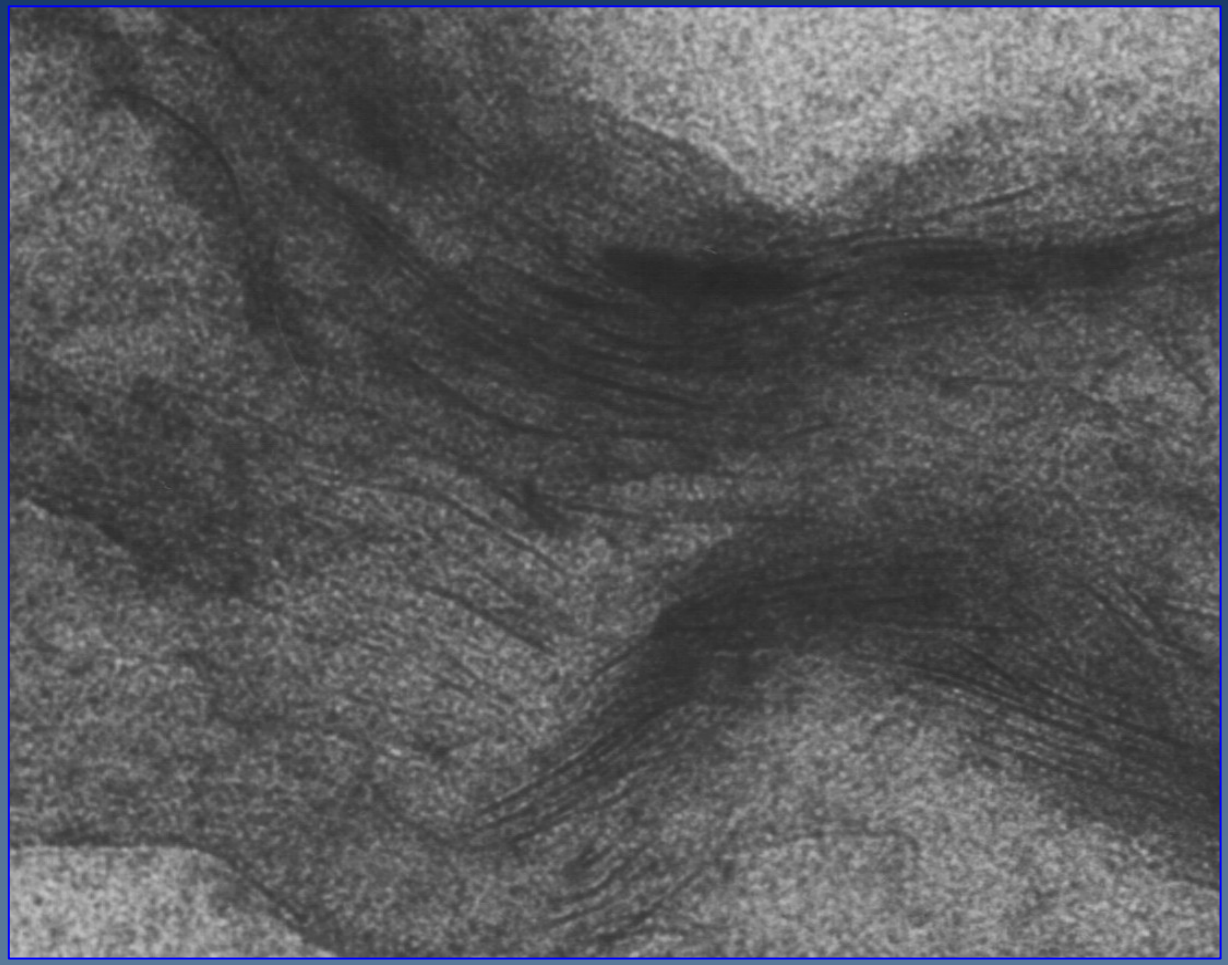


XRD pattern for WG and WG-MMT-Na (5%) composite



Diffractogram showed a similar pattern to that of WG without MMT-Na indicating that sufficient intercalation/exfoliation was achieved in these nanocomposites.

TEM images for WG-MMT-Na (5%)



1mm= 3.9 nm

SOY PROTEIN –MONTMORILLONITE NANOCOMPOSITE (MMT-Na+)

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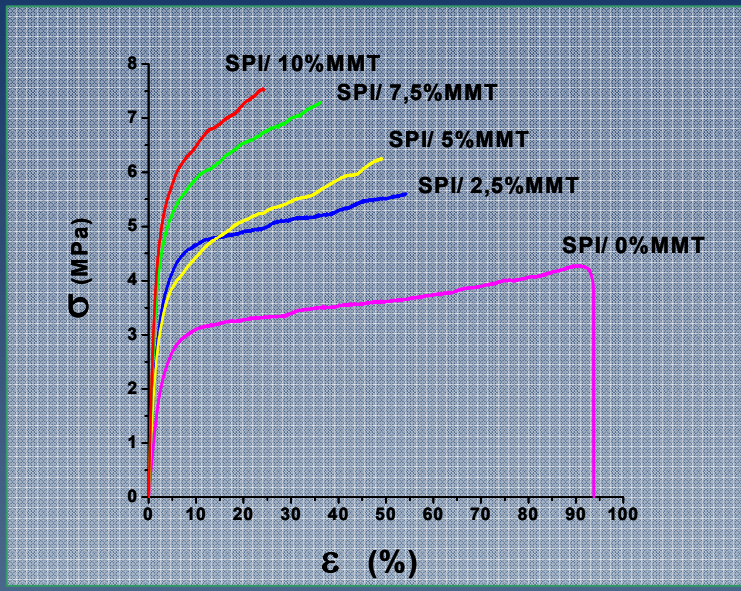
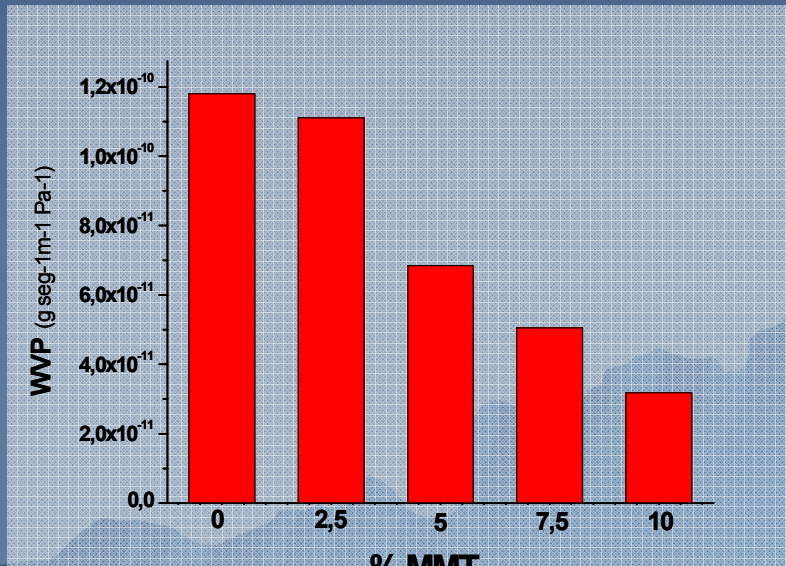
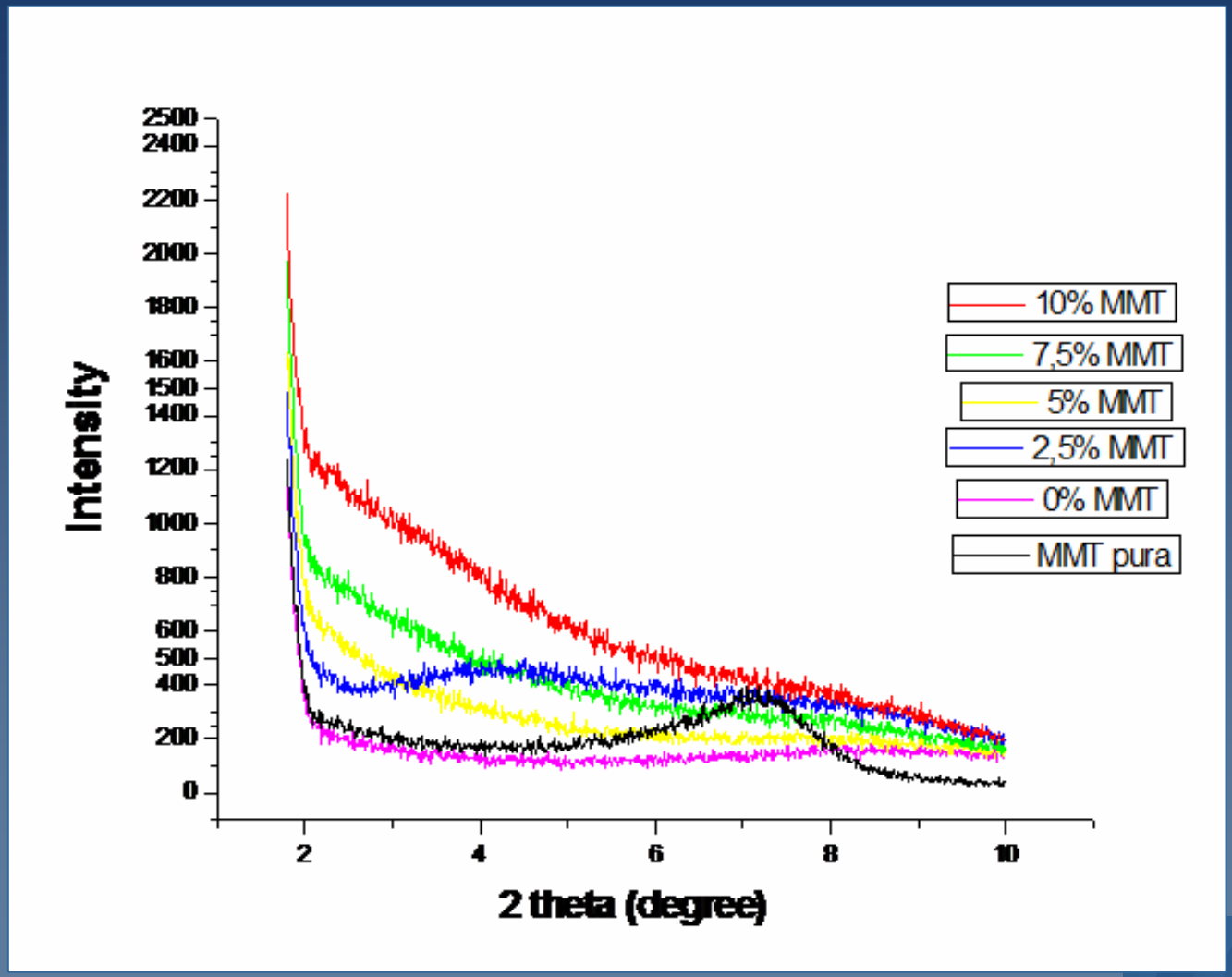
CIDCA-CONICE





XRD pattern for Soy and Soy-MMT-Na composite

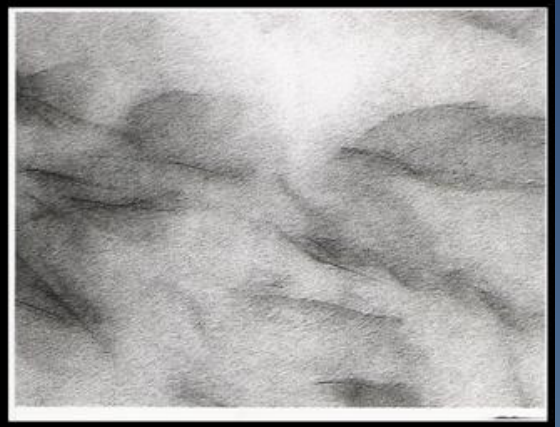


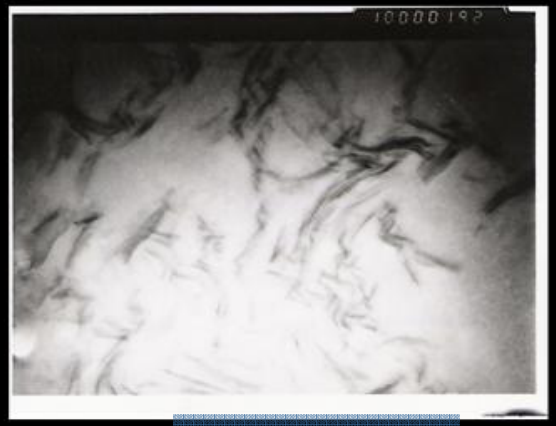
INTI-Plásticos
CIDCA-CONICET

0 % MMT

5 % MMT

10 % MMT



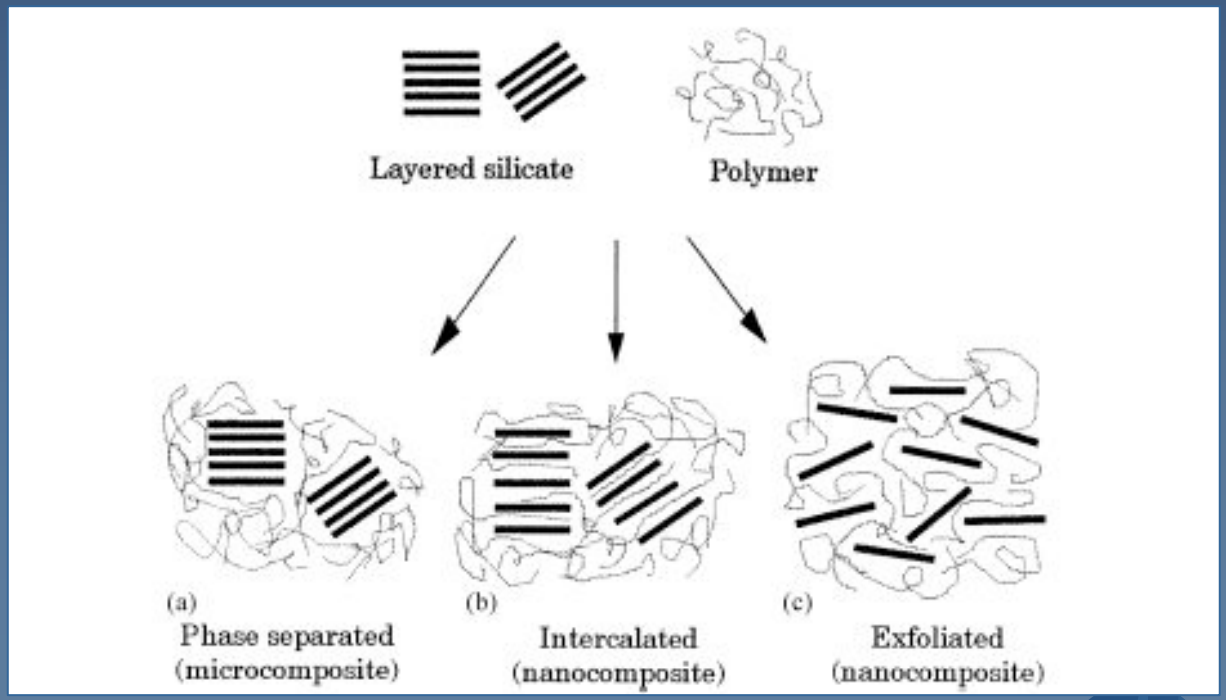


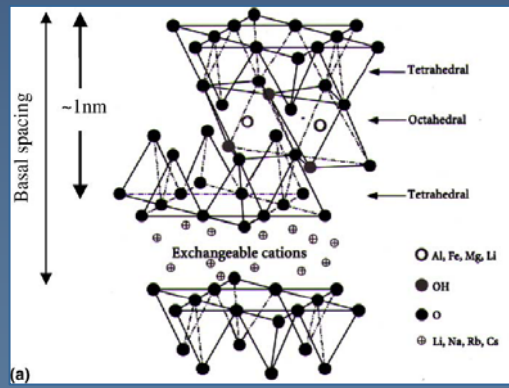
100.000 x

200.000 x

Nanoclays effects on protein composite films

- Increase mechanical properties
- Decrease water sensitivity
- Decrease water vapour permeability



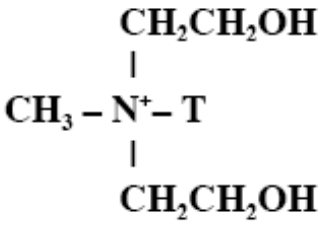


Polycaprolactone Nanocomposites (PCL-MMT)

Study of the influence of Montmorillonite structure in the PCL nanocomposite properties

Commercial grade poly (ε-caprolactone) FB 100 was supplied by Solvay Chemical (Perstorp caprolactones), mean Molecular Weight **>**100,000**;** melting Point 58ºC-60ºC.

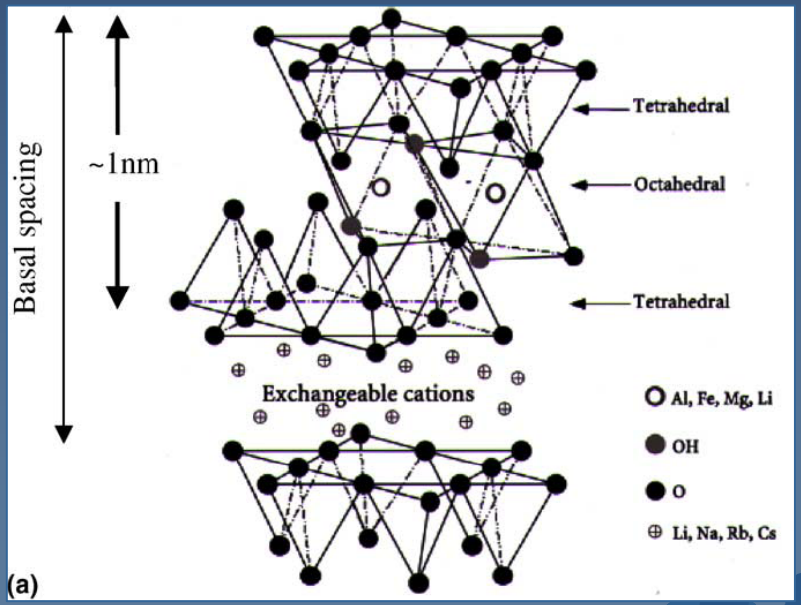
Clay minerals were ¨CloisiteTM Na+" (native montmorillonite) and "CloisiteTM 30B" (organic modified montmorillonite)(Southern Clay Products). Cloisite 30 B is a natural montmorillonite modified with a methyl, tallow, bis-2-hydroxyethyl, quaternary ammonium (Figure 1). The modifier concentration was 90 meq/100g clay. Clay moisture content was < 2 wt. % and its specific gravity was 1.98g/cc. Interlayer spacing d(001) was 1.85 nm.



Where T is Tallow (~65% C18; ~30% C16; ~5% C14)

Anion: Chloride

Cloisite 30B



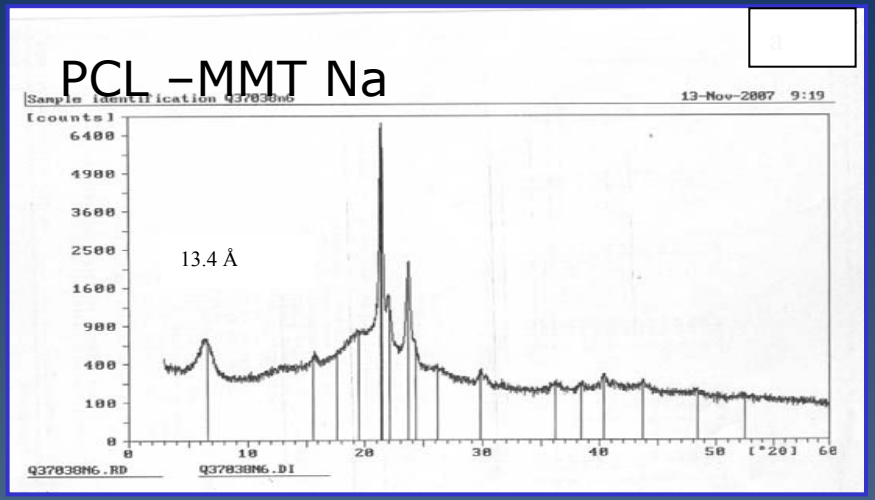
COMPOSITE PREPARATION

PCL/montmorillonite (PCL-MMT Na and PCl-MMT 30B) were prepared by melt intercalation in Brabender Plasticorder mixing chamber 30 cm3 , at 100 °C, 90 rpm for 10 min.

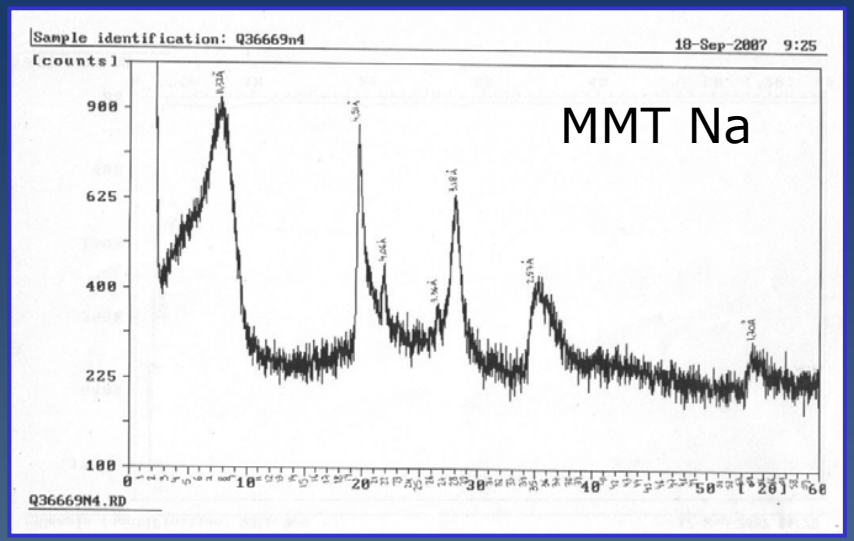
The collect molten materials were compression-molded into 0,4 mm-tick plates by hot pressing at 100 ºC for 2 min., and then 2 min under 50 bar. The nanocomposites contained 5% of MMT.

Analysis of clay dispersion and intercalation/exfoliation in the nanocomposite material.

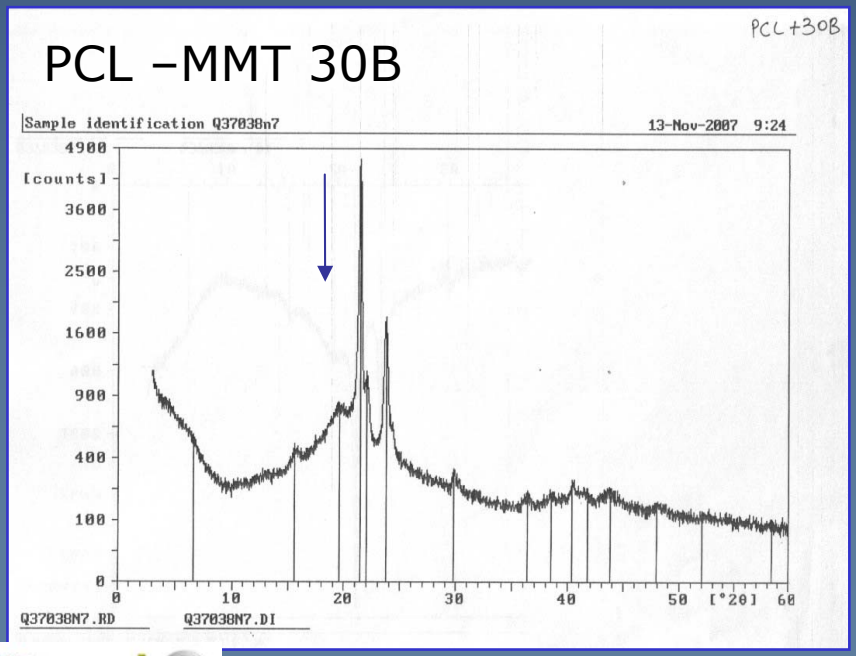
PCL –MMT Na



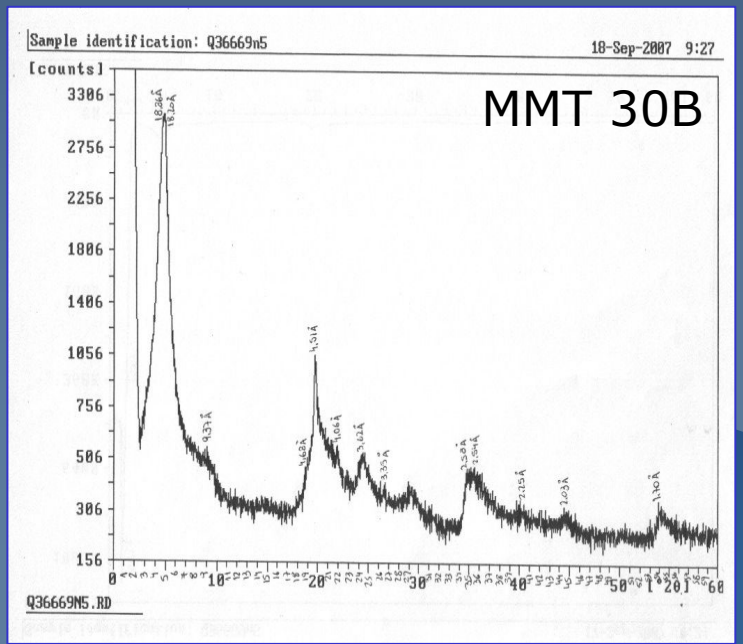
MMT Na



PCL –MMT 30B

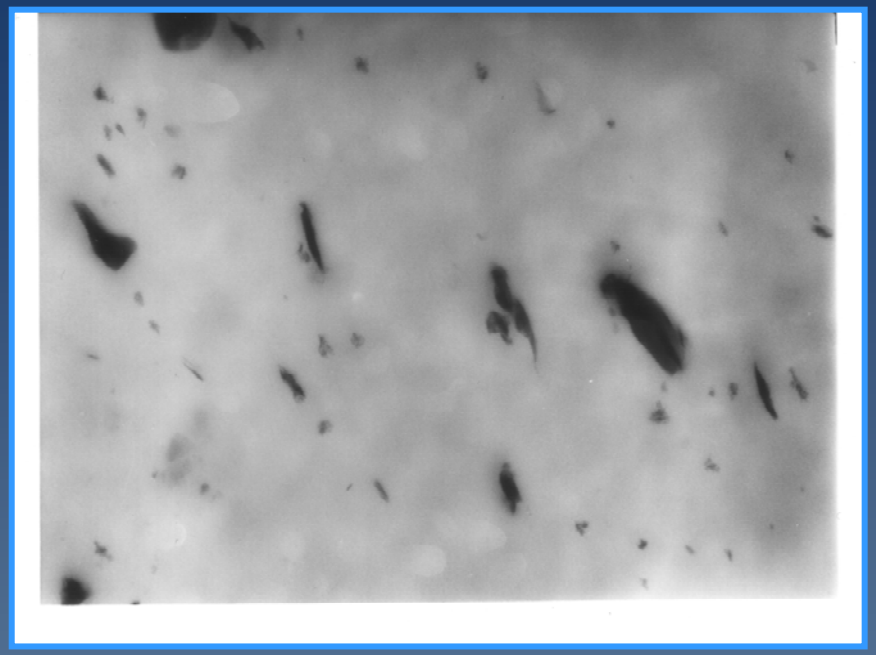


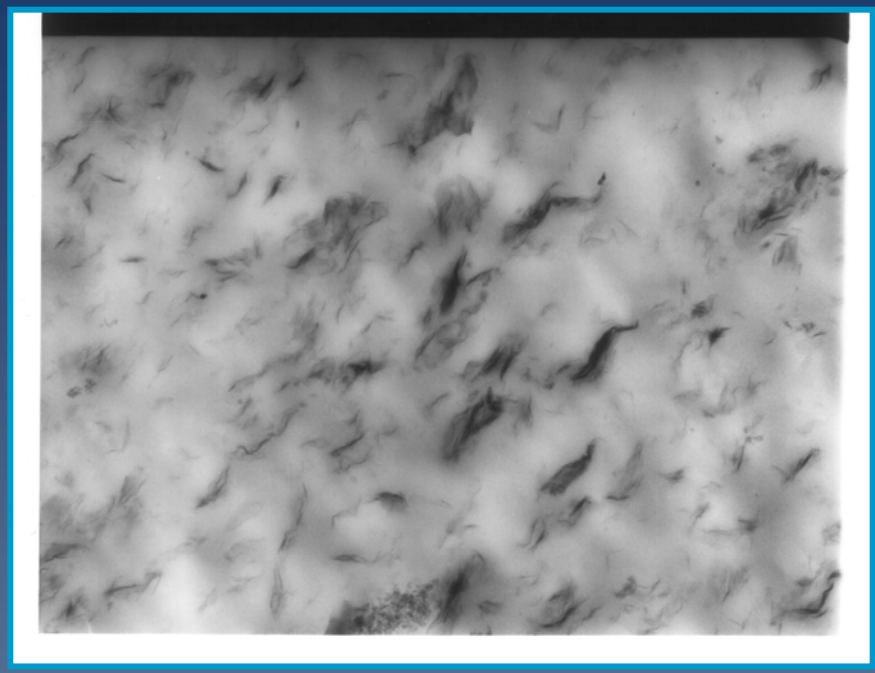
MMT 30B



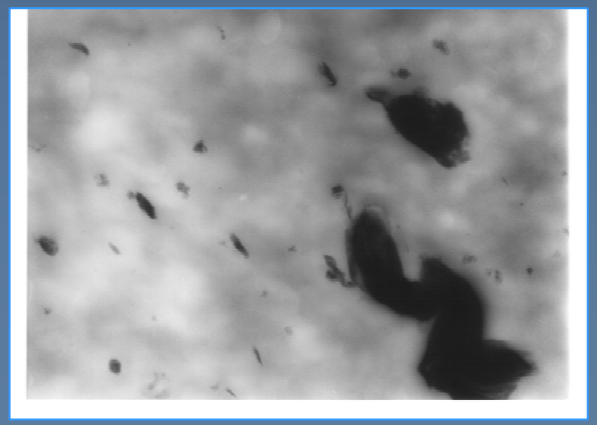
TEM Polycaprolactone Nanocomposites (PCL-MMT)

1 mm= 0.6 μm





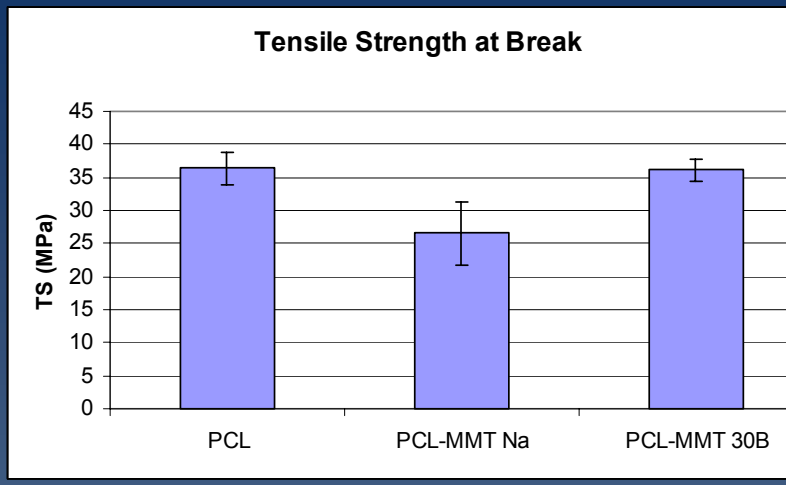
CL-MMT Na

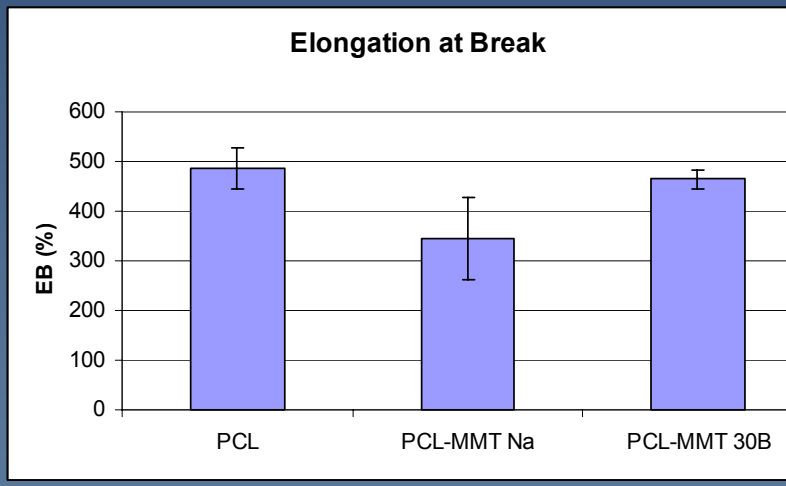


PCL-MMT 30B

Mechanical Properties

	Young modulus (MPa)	Tensile Strength at break (MPa)	Elong. at break (%)
PCL	414	36,4	486
PCL – MMT Na 5%	504	26,6	345
PCL-MMT 30B 5%	473	36,1	464





o difference between tensile strength for PCL and PCL-MMT 30 B, but lower alue was found for PCL-MMT Na. The same trend is observed for the elongation t break .These results agree with the intercalation/exfoliation structure for PCL-MMT 30 B observed by TEM and XRD

Comparative Burning Characteristics of Solid Plastics in a Vertical Position

The nanocomposite burning behaviour was studied by vertical burning test, adapted from UL 94

The procedure consists of subjecting a set of specimens of identical composition and geometry to a standard test flame for two 10s flame applications.

The after flame time is recorded after the first flame application (*t1*). After the second flame application , the after flame time is recorded (*t2*).

Information is also recorded out whether or not flaming material drips from the specimen and total flame time for a particular specimen set.

- The different burning characteristics found for PCL- MMT 30 B compare to PCL and PCL-MMT Na could be due to clay intercalated/exfoliated and percolated in the PCL matrix.

- This interaction provides physical integrity to the material burning, avoiding a configuration in which dripping of flaming material could occur, which constitutes an additional fire propagation to surrounding materials

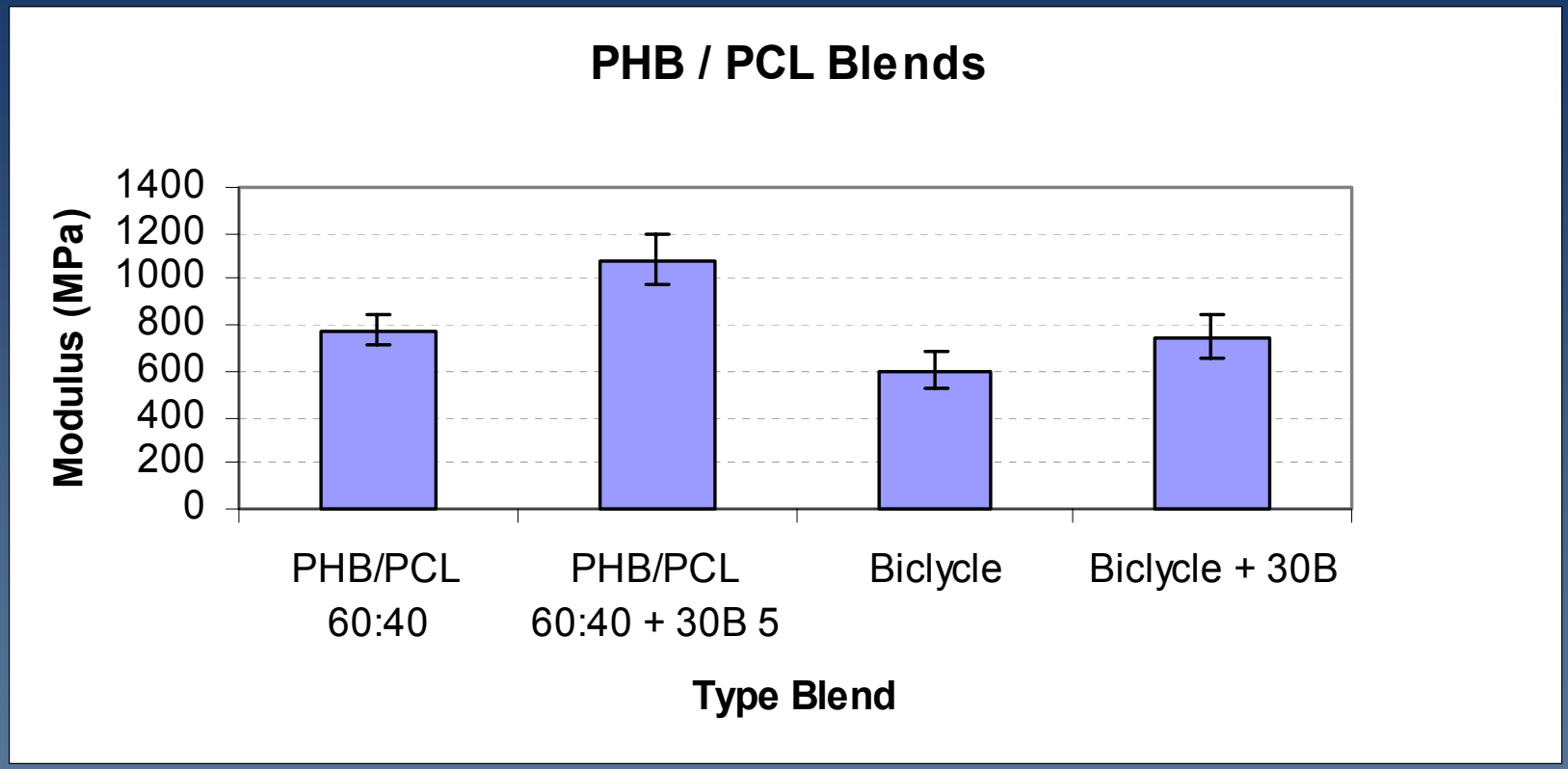
Nanocomposites PCL / PHB /MMT 30 B

Preliminary evaluation of the effect of organic modified MMT 30B on one particular composition of PHB/PCL blend, similar to the composition of a commercial PHB/PCL blend, was done.

PCL FB 100 was supplied by Solvay Chemical

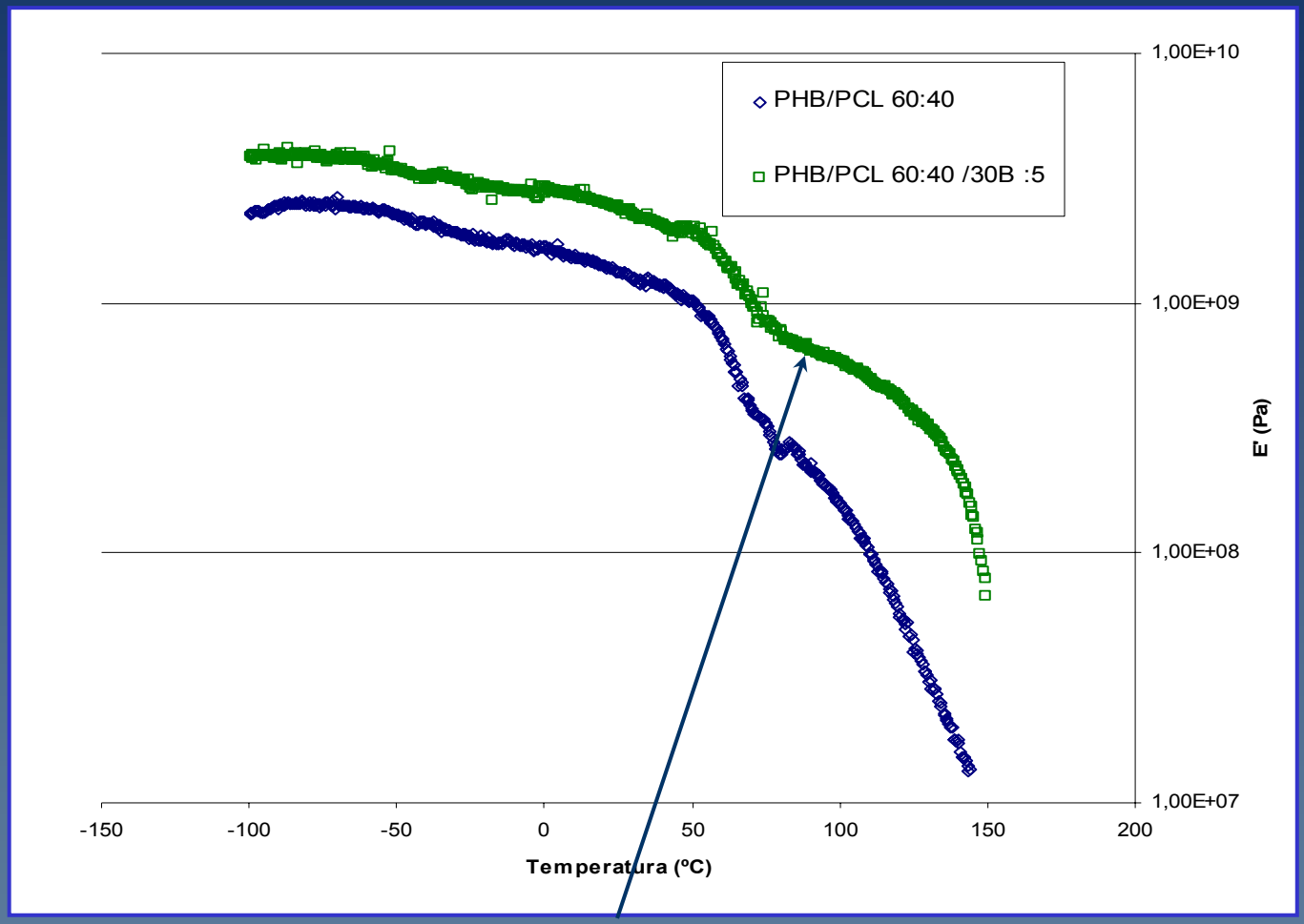
PCL/PHB 40/60 blends and Biocycle (Industrial PHB S.A. (Brazil) nanocomposites (5% MMT-30B) were prepared in Brabender Plasticorder mixer at 170º C/80 rpm/ 10 minutes.

Mechanical Properties



A 38 % increase in modulus was observed for the nanocomposite PCL/PHB (40/60)-MMT 30 B.
For the commercial polymer Biocycle nanocomposite a 24 % increase in modulus was observed.

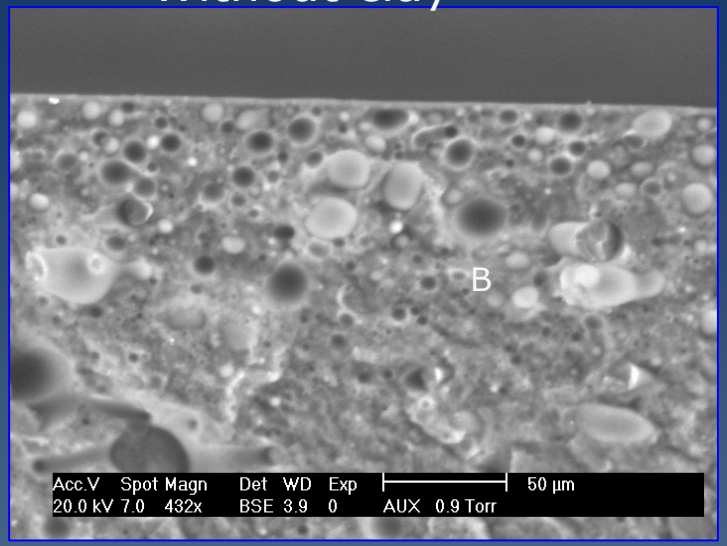
DMTA of PCL/PHB (40/60) blend and nanocomposite



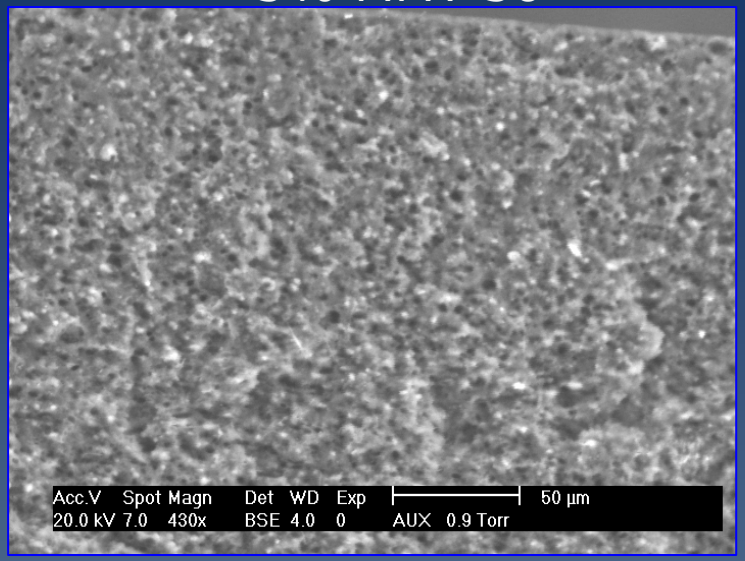
MMT 30 B allows the use of this composite blend in temperature range where the PCL/PHB (40/60) blend has already a constant decay in modulus value.

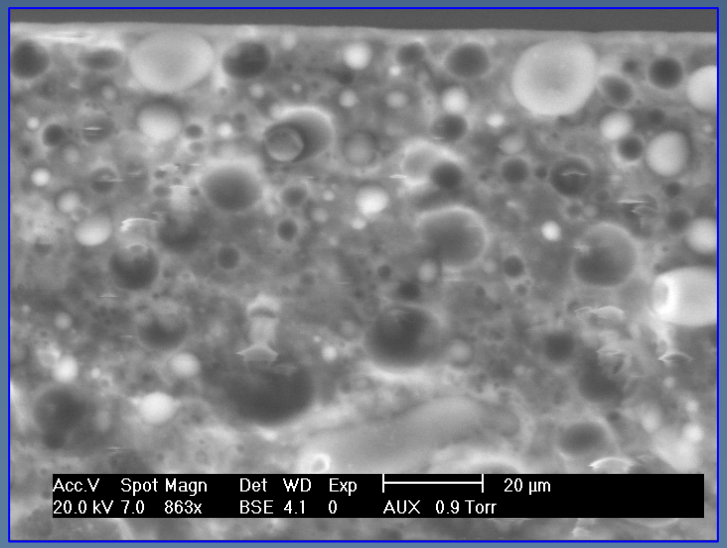
SEM PHB/PCL 40/60 blend and PCL/PHB –MMT 30 B

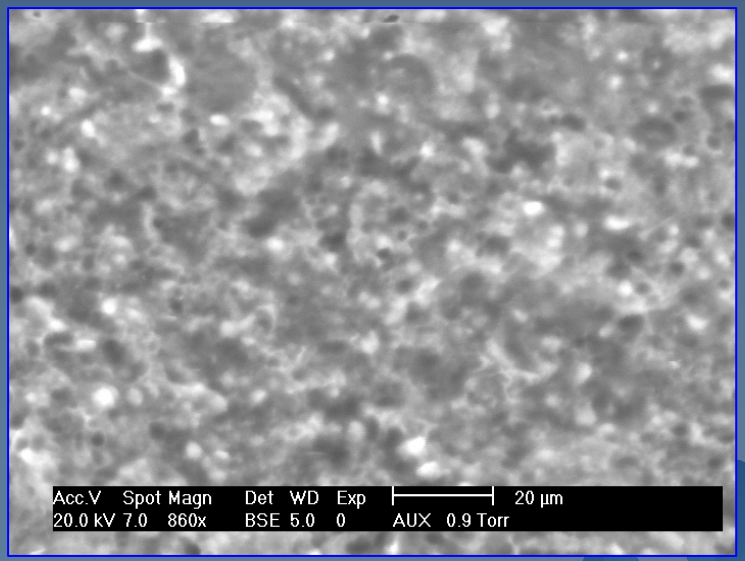
Without clay



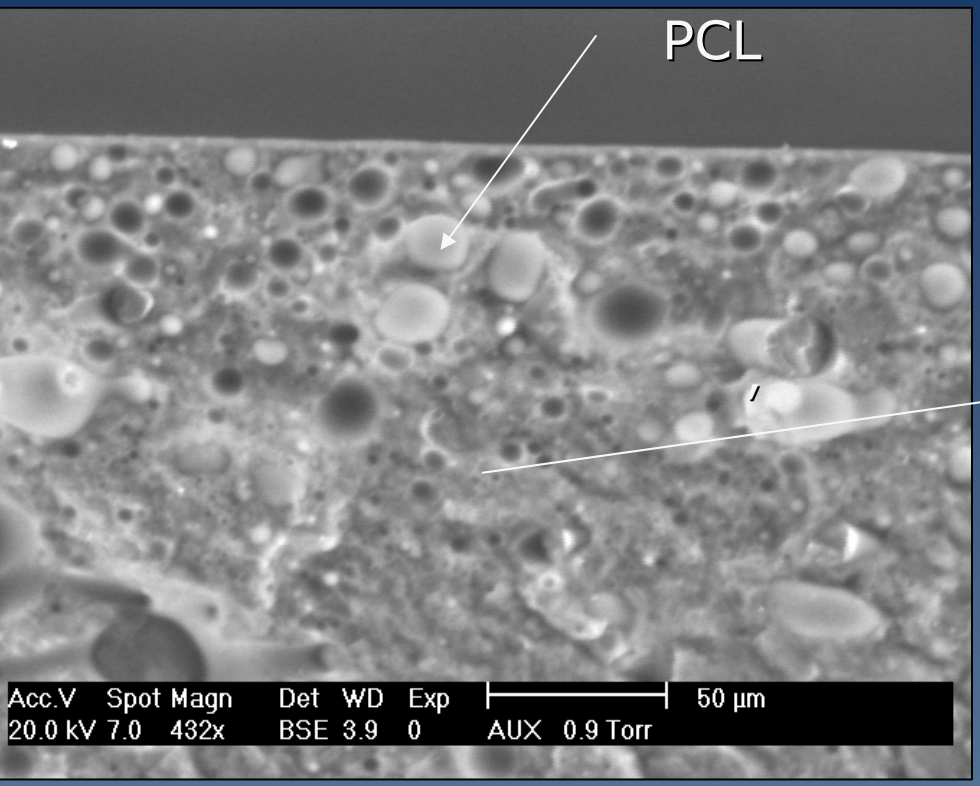
5% MMT 30

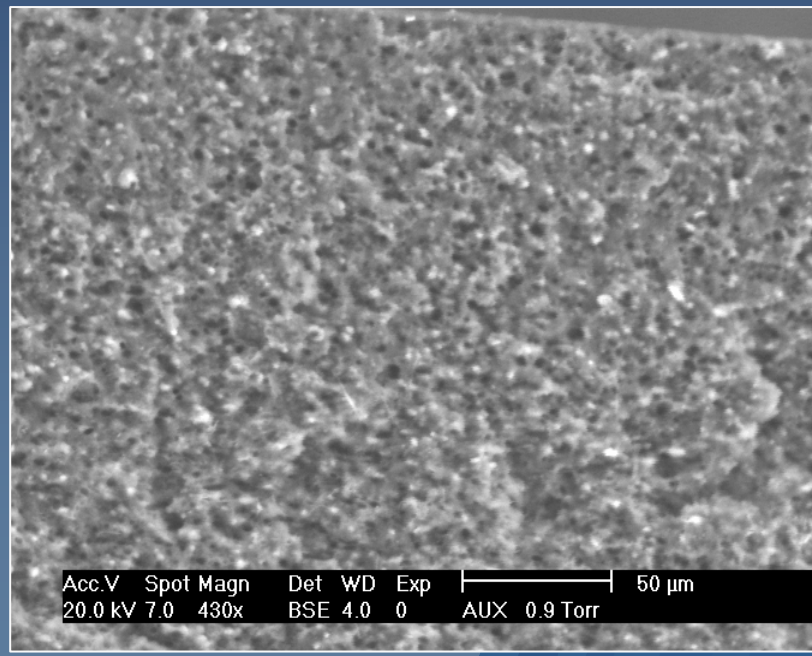






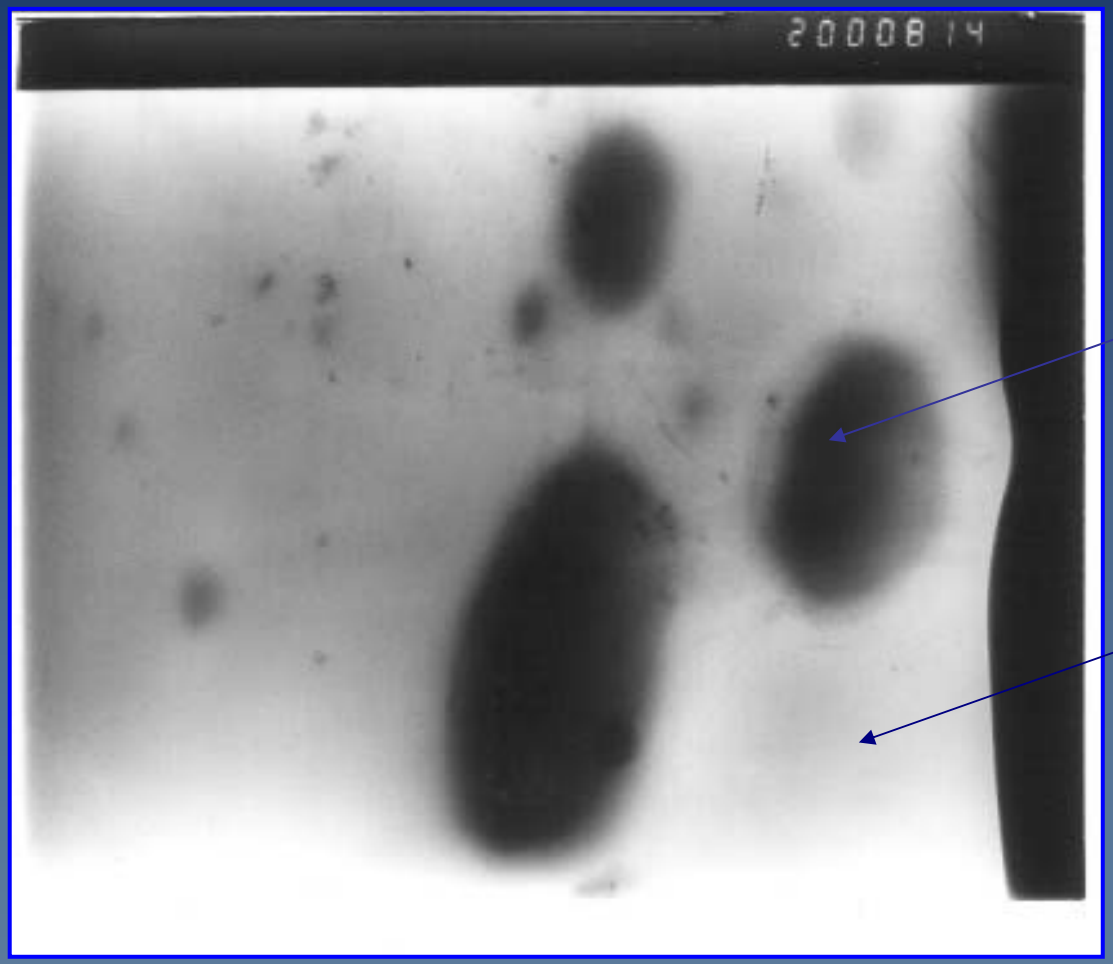
SEM images PCL/PHB 40/60, PCL/PHB40/60–MMT 30 B



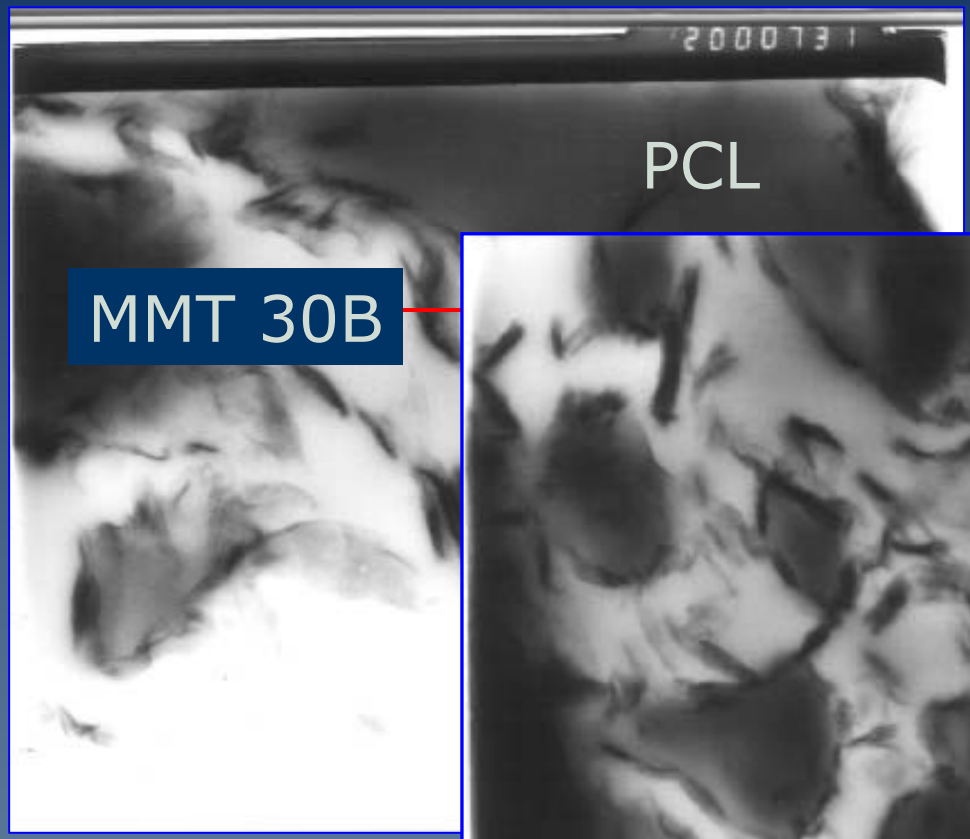


PCL disperse phase domain size decreases drastically when nanoclay is incorporated due to the localization of the clay in the interfacial region (TEM)

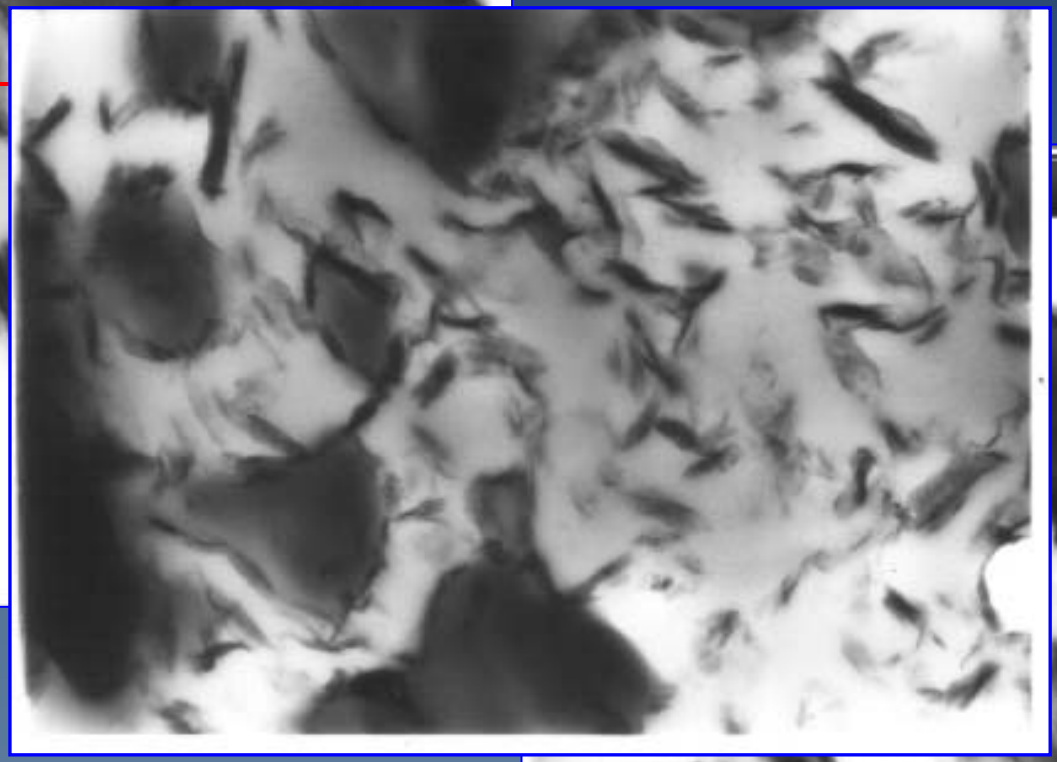
TEM image of PCL/PHB (40/60) blend



TEM images PCL/PHB40/60–MMT 30 B



MMT 30B



- PCL/PHB 40/60, PCL/PHB40/60–MMT 30 B and Biocycle nanocomposite SEM images show that the disperse phase domain size decreases drastically when the MMT 30 B is incorporated, in both materials.

This behavior is due to the localization of the clay in the interfacial region, as it was confirmed by TEM images.

PCL/PHB (40/60) nanocomposite 38 % increase in modulus compare to PCL/PHB (40/60) blend.