Natural Fibre Based biodegradable polymers

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CECB

“Green plastics from cellulose”

- A future vision of degradable plastics

- Meeting the challenge :
- …Carbon footprint…Aqueous…Biocompatible…Environmental…
- …Biodegradable…Recycle…Non-fossil…Renewable…Low energy…

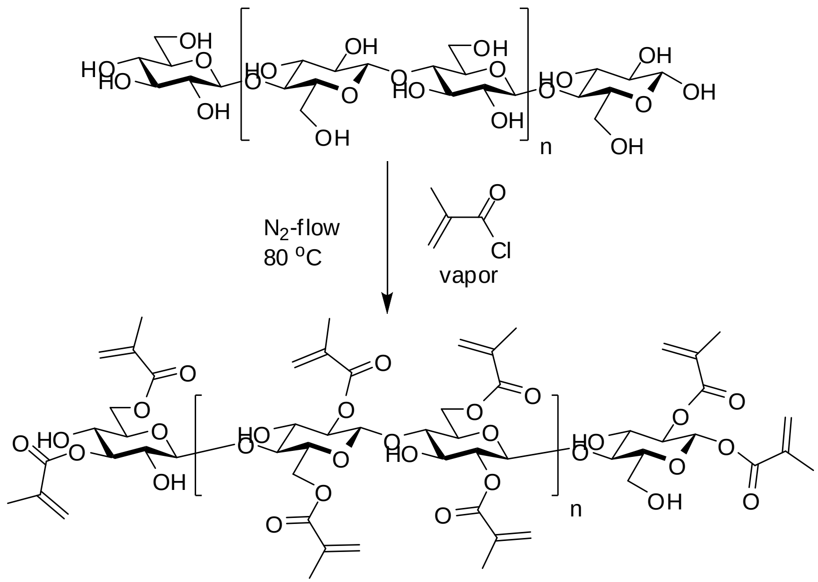
Carlsberg Laboratory

CECB

Morten Meldal, Manat Renil, Helene Rossignol, Steen Vesborg

✓ CO_2 ✓ Energy ✓ Water

“Green plastics from cellulose”



Environment friendly:

No solvents !!!

No excess of reagents

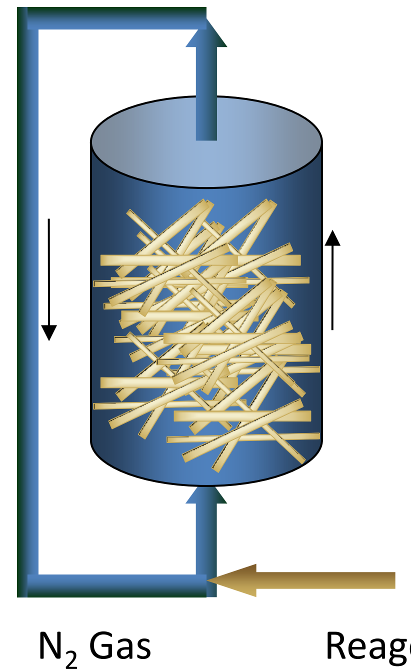
No washing steps

N_2 as carrier gas

Little byproducts

Reduced energy

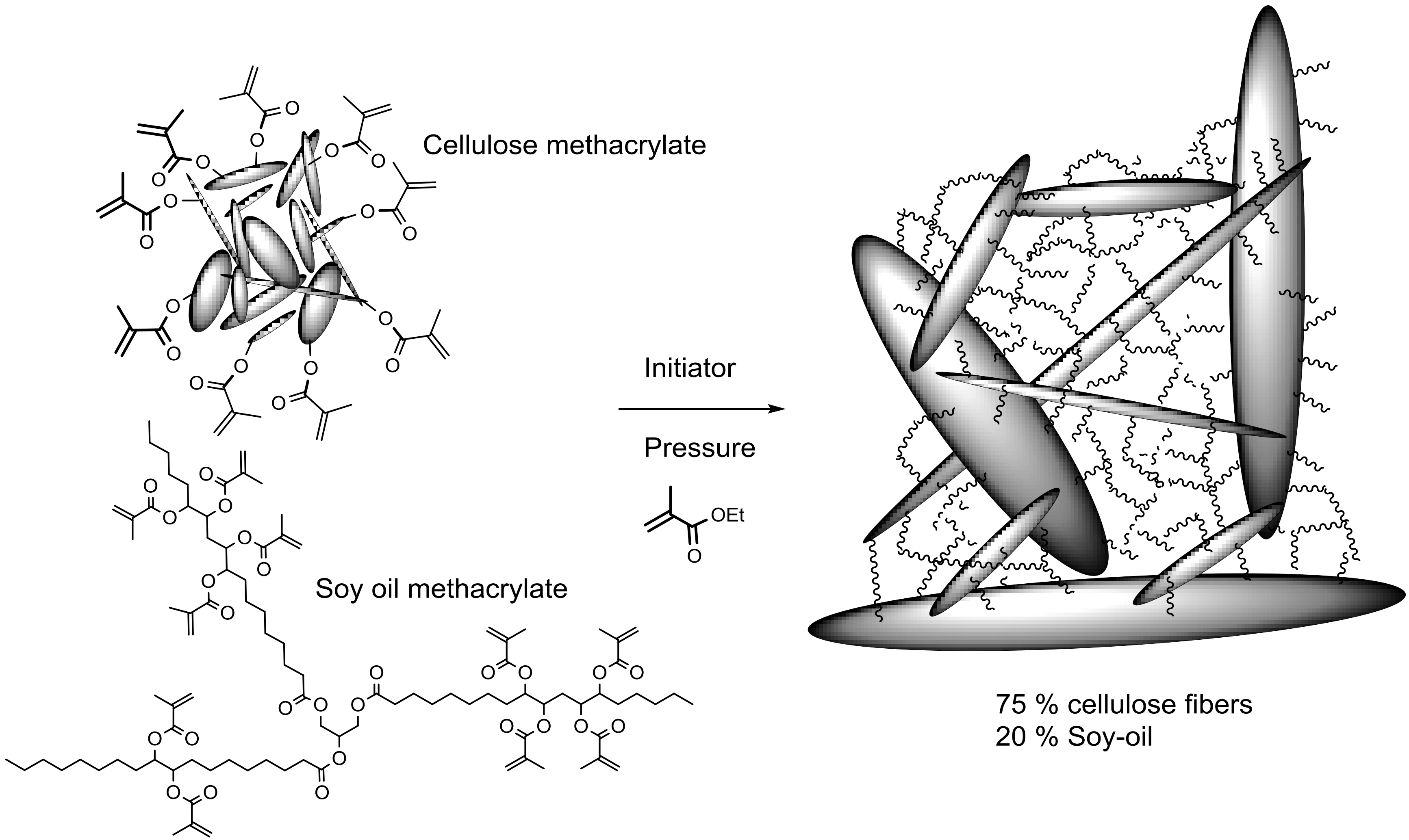
Gas phase acryloylation



- Produce larger amounts by gas phase reaction.
- Formulation for standard industrial processes
- Many applications

✓ CO_2 ✓ Energy ✓ Water

Surface modified macromonomer fiber and Soy bean oil



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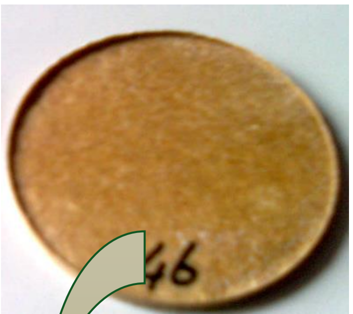
Biodegradable material:

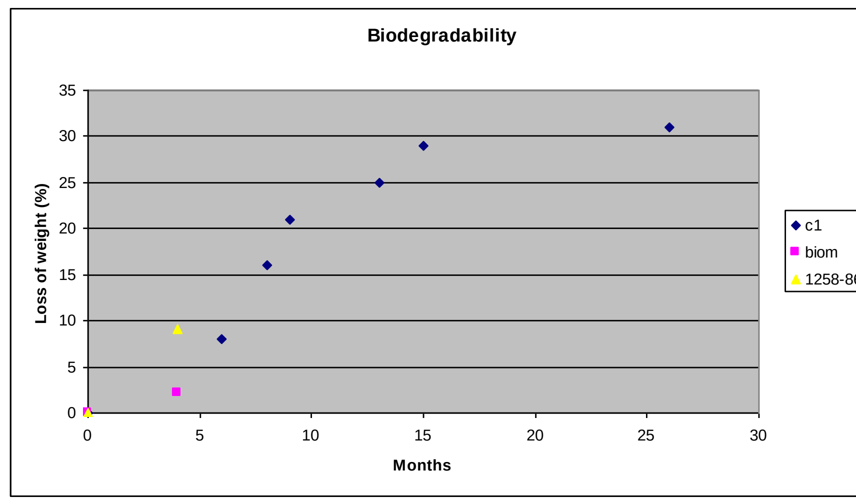
- Sustainable process and product
- Growth area
- Natural fiber plastic
- Renewable,
- Biodegradable
- Use of waste stream
- Packing, Construction materials Utensils etc



15 Months
in soil 29 %

PET: 0 % loss
BioM 2% / 4 m

Loss up to 90 % with polymer made from cellulose and soy oil



✓ CO_2

✓ Energy

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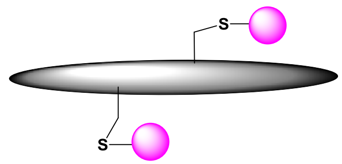
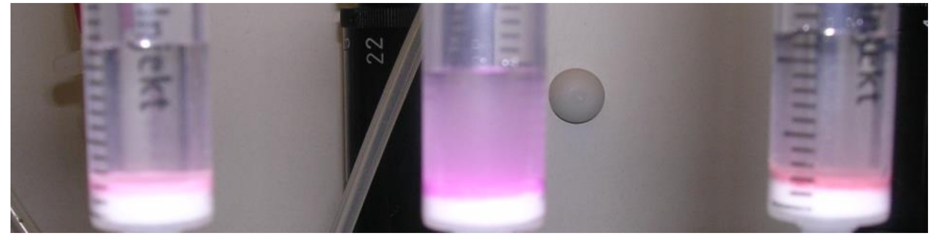
“Green plastics from cellulose”





1.Vapour 60ºC 2. DCM/TEA 3. Vapour 80ºC

✓ CO_2

✓ Energy

✓ Water

“Green plastics from cellulose”

3 mm thickness

Barley Coir Sisal

✓ CO_2 ✓ Energy ✓ Water

DMA of selected polymers

Materials

3 mm thickness

Tensile Strength

DMA

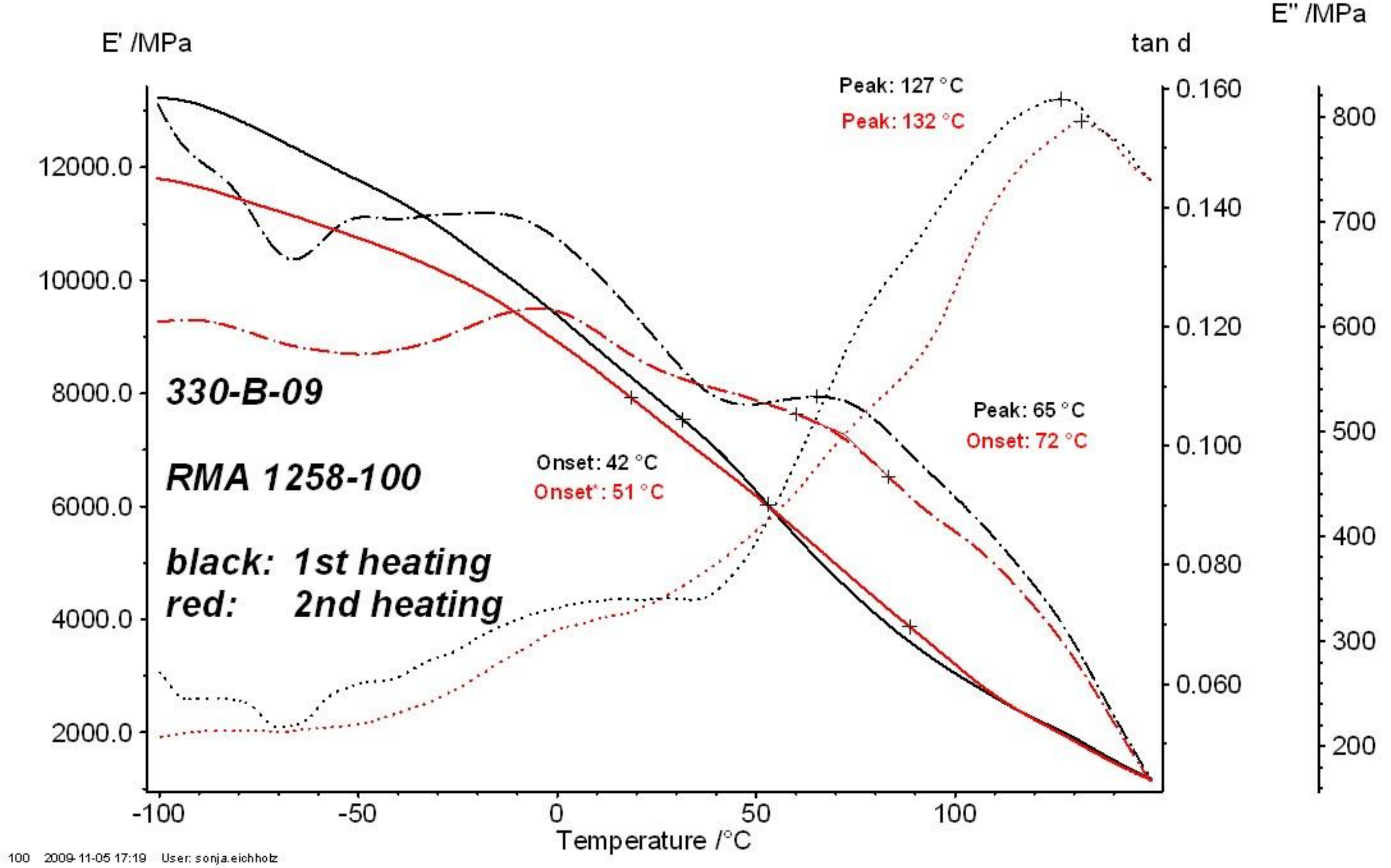
CO_2 permeability

Coir Sisal

Barley

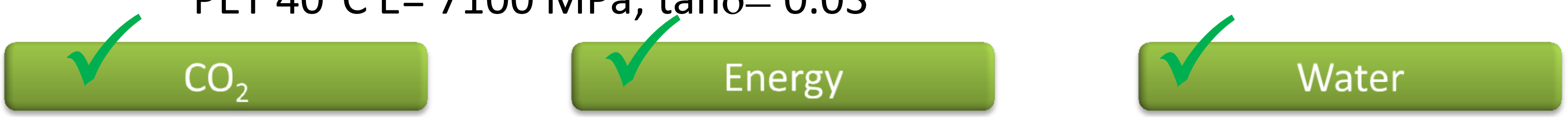
✓ CO_2 ✓ Energy ✓ Water

DMA of selected polymers

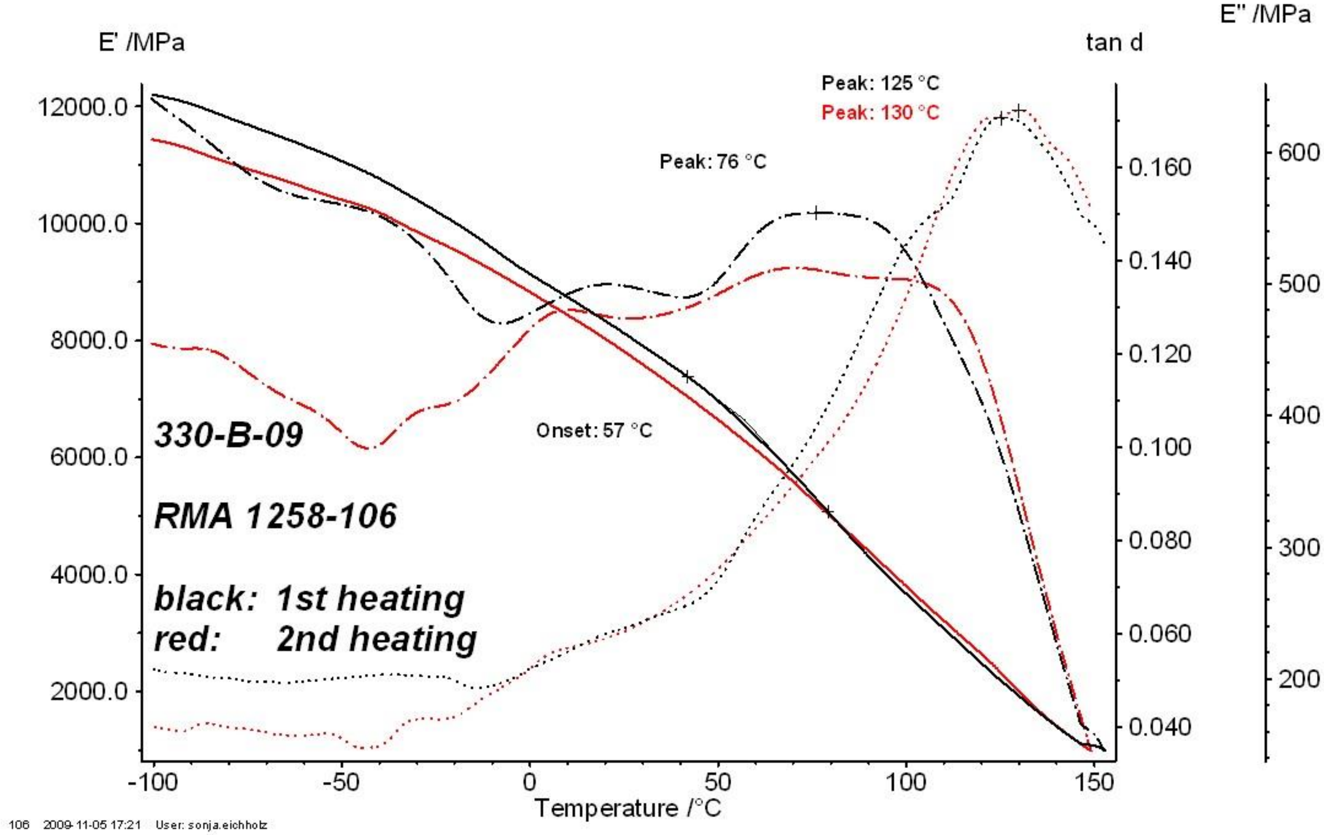


At 40°C E'= 7000 MPa; tanδ =0.075

PET 40°C E= 7100 MPa; tanδ= 0.03



Dynamic Mechanical Analysis



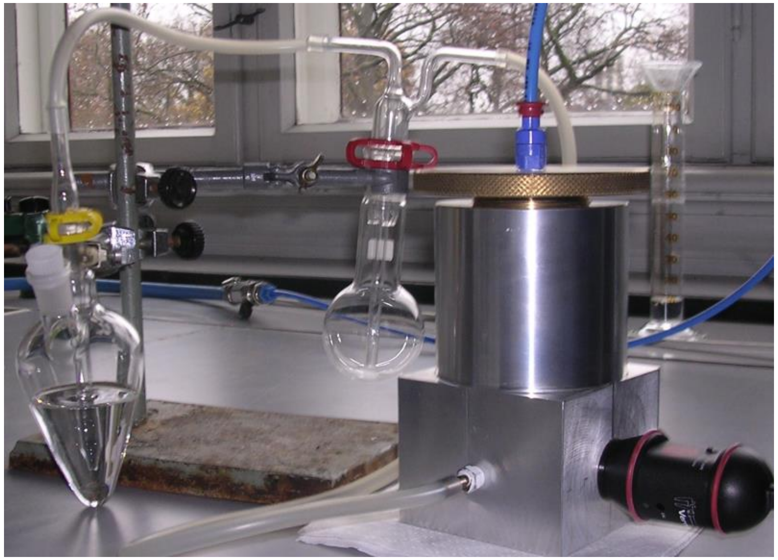
At 40°C E'= 7900 MPa; $\tan\delta = 0.065$

PET 40°C E'= 7100 MPa; $\tan\delta = 0.03$

✓ CO_2 ✓ Energy ✓ Water

Carbon dioxide permeability studies

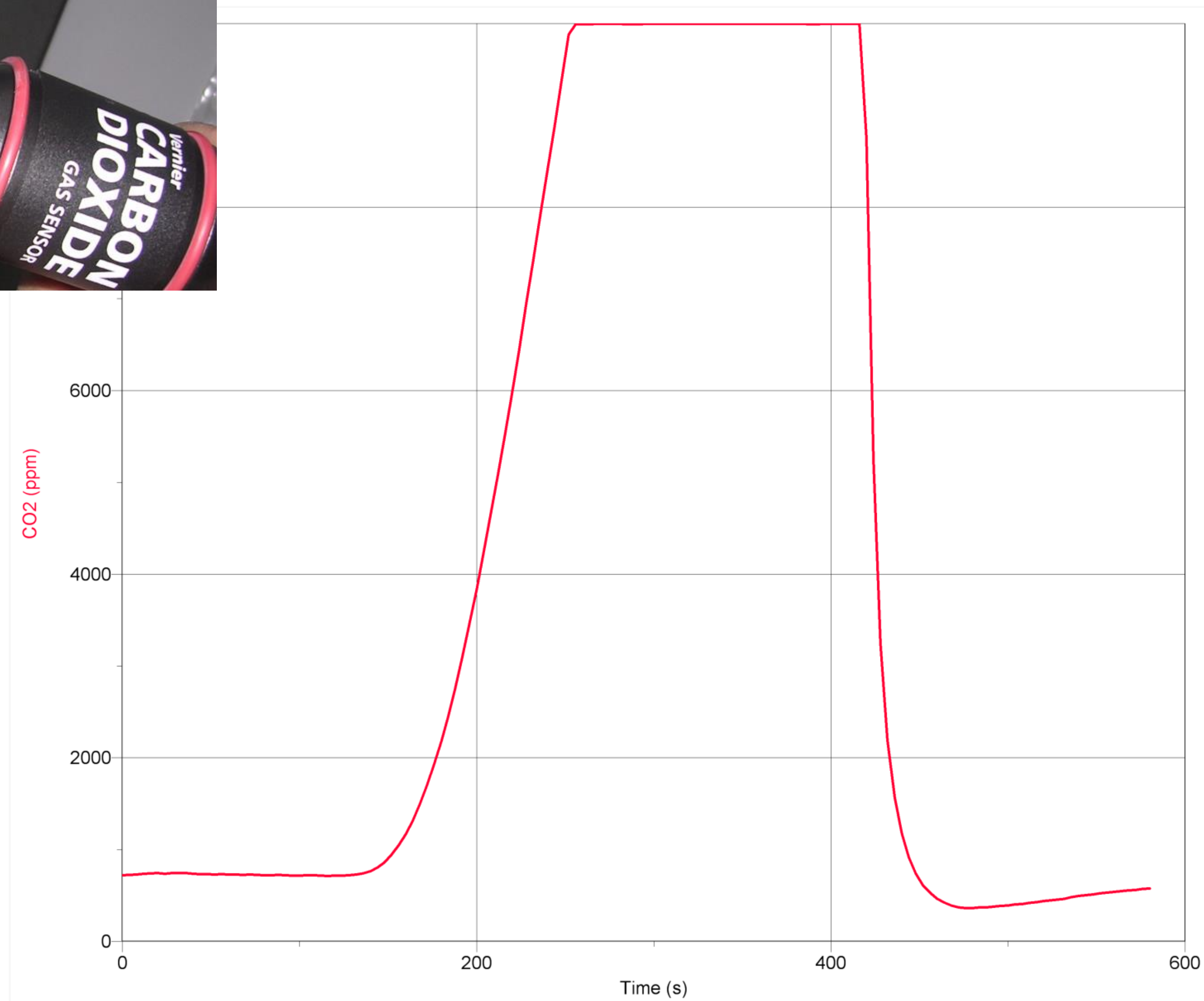
- Carbonated water under 4 bar CO_2 pressure for 4 days.
- Continuous monitoring using a IR detector.
- Negative control Metal disc,



Carbon dioxide- gas

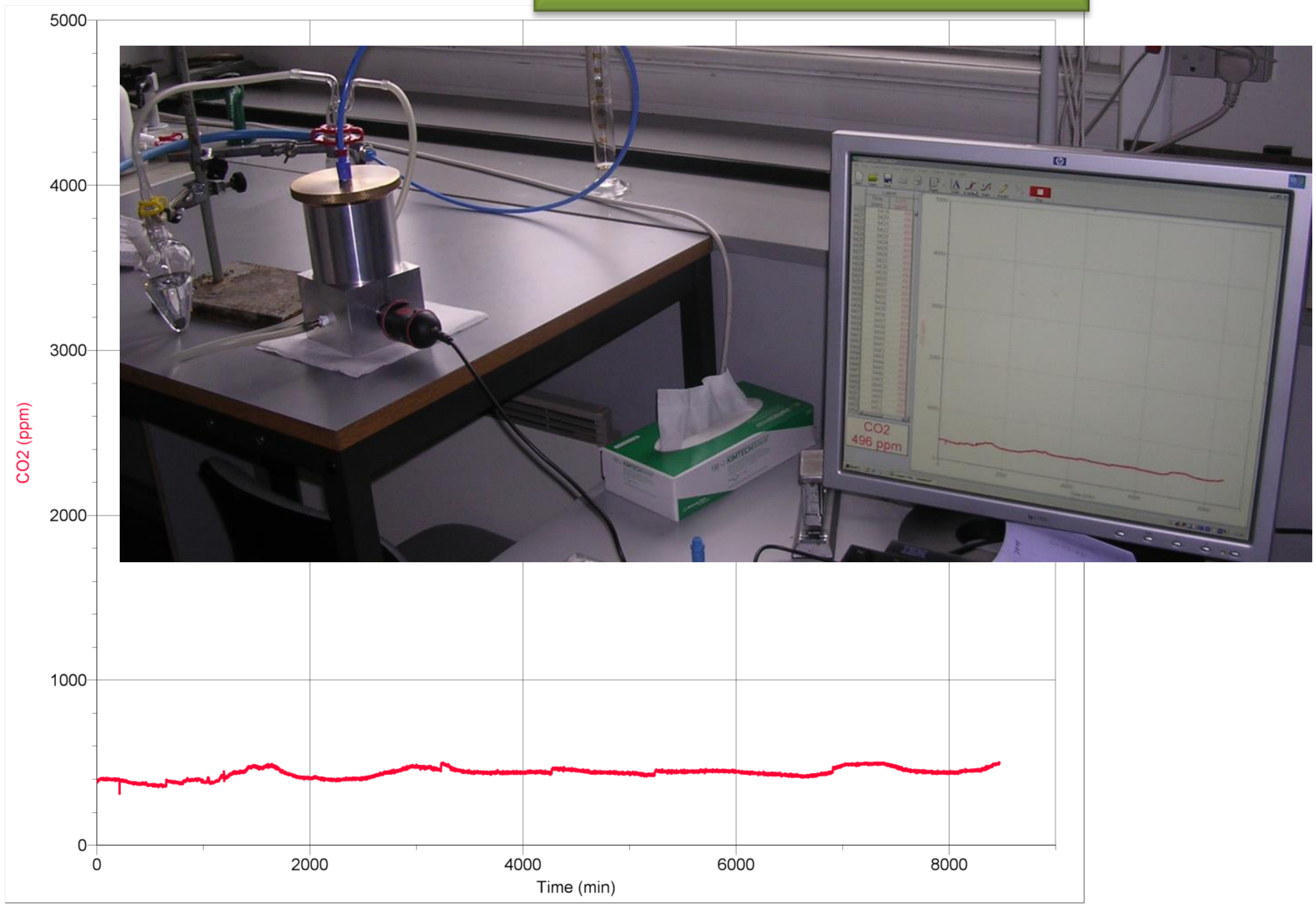
Positive control

742
10,000
396 ppm



Carbonated water 4 bar CO_2

Negative control
Metal
0.5 mm thick

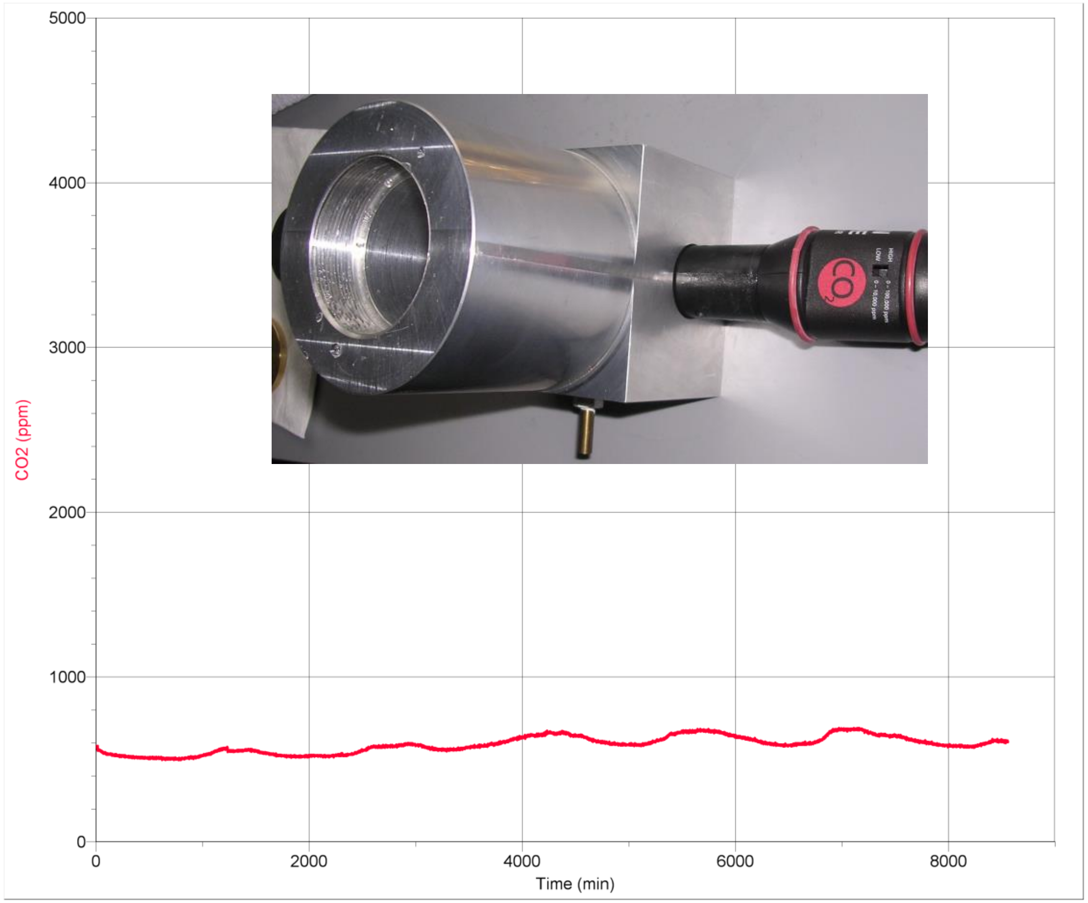


398 ppm
406-490

Carbonated water 4 bar CO_2

PET
0.3 mm thick

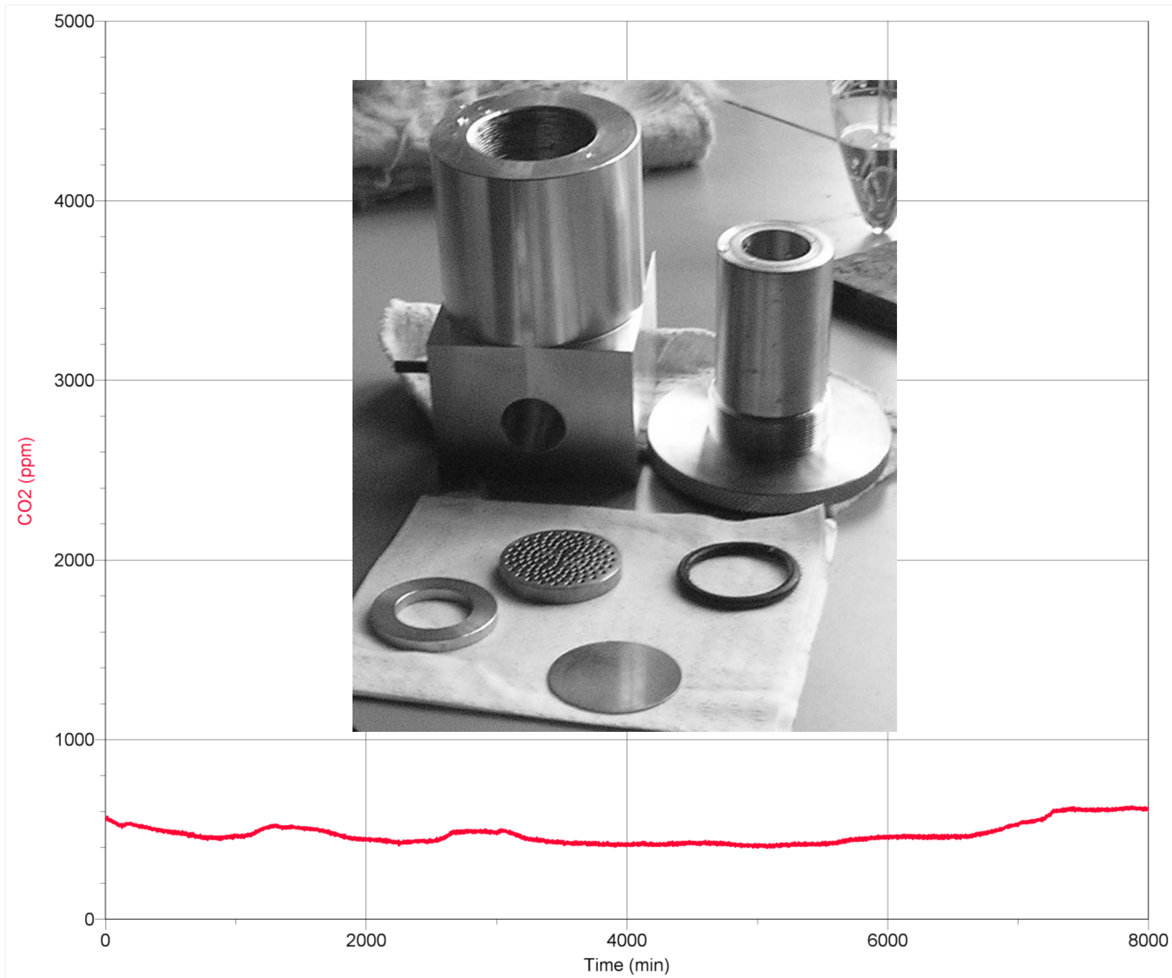
578 ppm
523-588

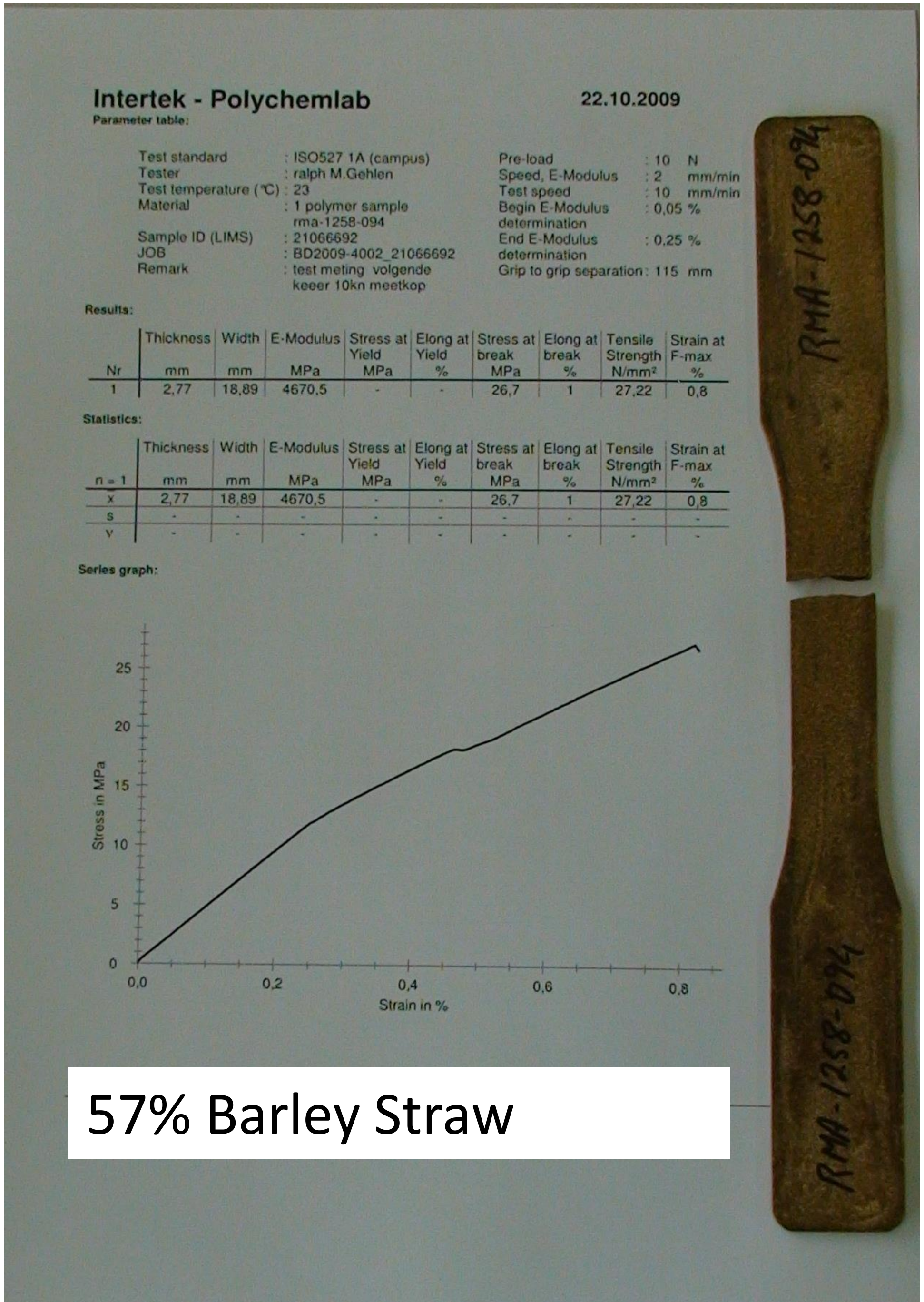


Carbonated water 4 bar CO_2

64% Cellulose
2.9 mm thick

562 ppm
445-612





Intertek - Polychemlab 22.10.2009

Parameter table:

Test standard	: ISO527 1A (campus)	Pre-load	: 10 N
Tester	: ralph M.Gehlen	Speed, E-Modulus	: 2 mm/min
Test temperature (°C)	: 23	Test speed	: 10 mm/min
Material	: 1 polymer sample rma-1258-094	Begin E-Modulus determination	: 0,05 %
Sample ID (LIMS)	: 21066692	End E-Modulus determination	: 0,25 %
JOB	: BD2009-4002_21066692	Grip to grip separation	: 115 mm
Remark	: test meting volgende keeer 10kn meetkop		

Results:

Nr	Thickness mm	Width mm	E-Modulus MPa	Stress at Yield MPa	Elong at Yield %	Stress at break MPa	Elong at break %	Tensile Strength N/mm²	Strain at F-max %
1	2,77	18,89	4670,5	-	-	26,7	1	27,22	0,8

Statistics:

n = 1	Thickness mm	Width mm	E-Modulus MPa	Stress at Yield MPa	Elong at Yield %	Stress at break MPa	Elong at break %	Tensile Strength N/mm²	Strain at F-max %
x	2,77	18,89	4670,5	-	-	26,7	1	27,22	0,8
s	-	-	-	-	-	-	-	-	-
v	-	-	-	-	-	-	-	-	-

Series graph:

57% Barley Straw

E-Modulus
4670.5 Mpa

Tensile strength
> 27 Mpa

PET, *E-Modulus*
2800-4100 Mpa

Tensile Strength
48 MPa

“Green plastics from cellulose”

Utilizing the waste streams from agriculture

A new strong and sustainable material:

- Optimal biodegradability, like wood
- Only degraded in soil
- Water resistant
- Excellent gas barrier properties
- Moulded into shape

- Structurely strong substitute for polymers
- Construction materials
- Furnitures and utensils
- Packeting materials and more

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