Performance of a new bio-based thermal insulation board

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EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

COST FP1303
Performance of bio-based building materials

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CO_2 emissions related to housing heating in Spain (in tones)

Potential demand of **170 million m³** of thermal insulation materials up to 2050

		1			≥ 2			Nº de viviendas
		< 10.000 h	10.000 - 100.000 h	> 100.000 h	< 10.000 h	10.000 - 100.000 h	> 100.000 h	Dimensión del núcleo
< 1960	1 - 3	2.360.627	402.144	168.203	300.104	139.742	109.041	A
	≥ 4	1.328	715	536	119.125	312.149	1.008.835	B
1960 - 1980	1 - 3	1.474.896	383.626	102.111	326.321	173.806	78.140	C
	≥ 4	1.346	780	505	358.138	1.115.044	2.451.164	D - E - F
1981 - 2001	1 - 3	2.005.125	647.202	206.566	342.523	188.162	71.005	G - H
	≥ 4	1.875	1.536	1.392	223.803	570.887	791.579	I - J
Año de construcción	Plantas sobre rasante							Hotspots

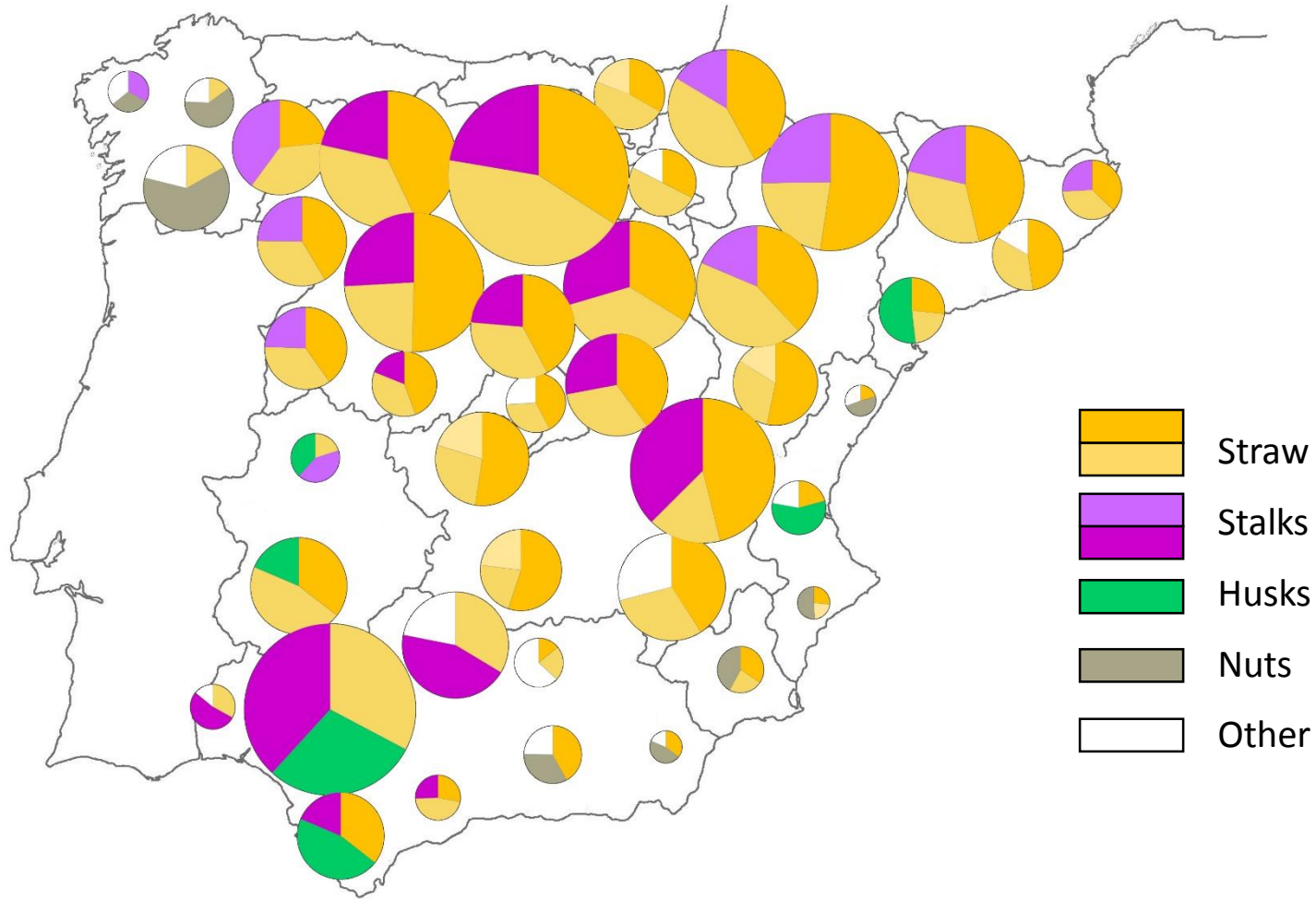Source: Cuchí and Sweatman. Informe GTR 2010.

Insulation: **97%** non renewable. Bio-based materials mainly **imported**

CO_2 emissions for the production of 1 kg of several building materials
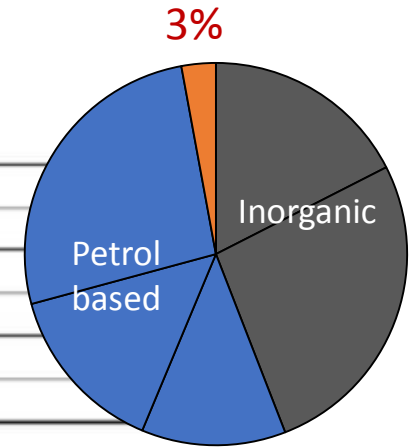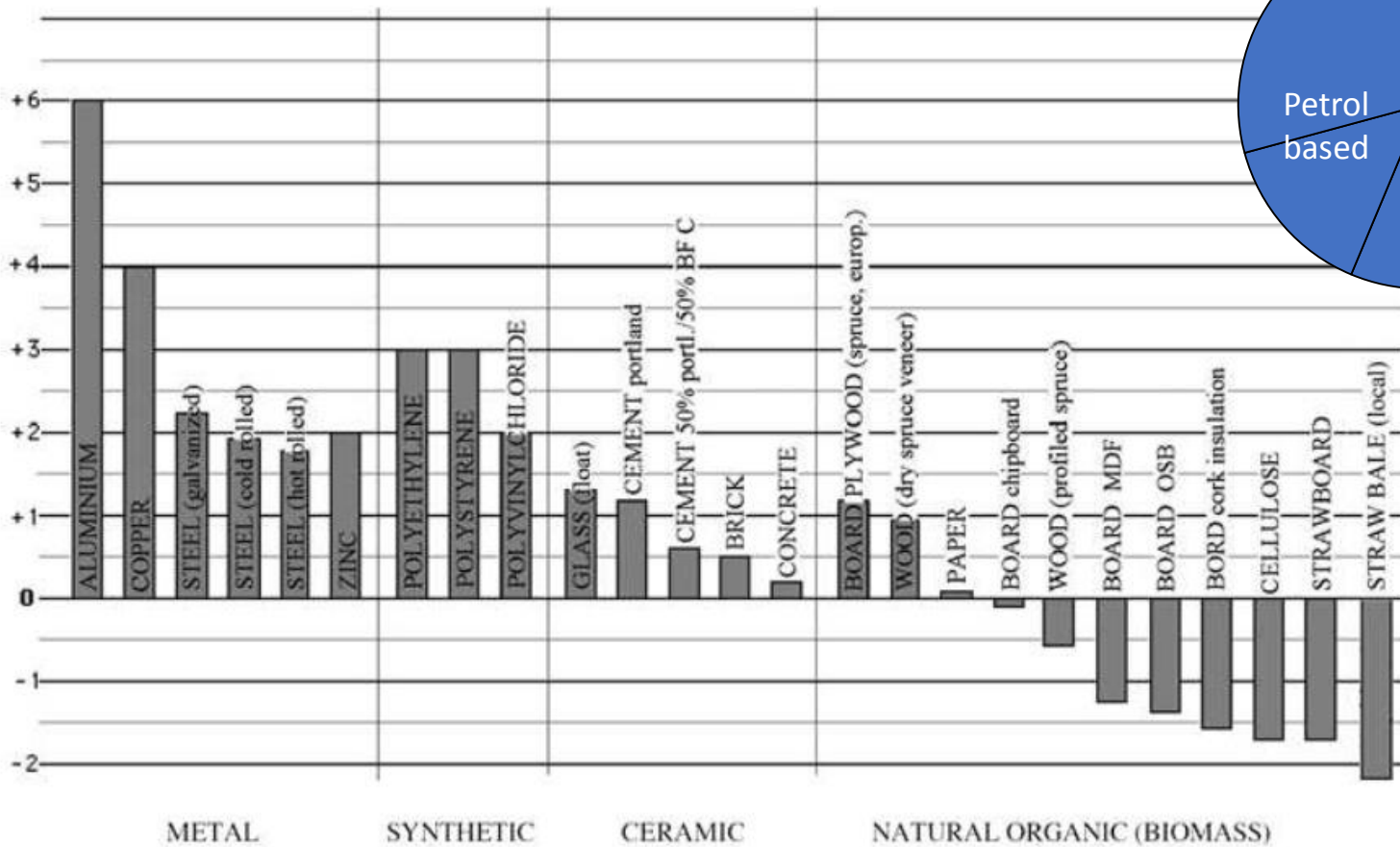
Source: Wihan J. 2007. Humidity in straw bale walls and its effect on the decomposition of straw

Availability of crop by-products in Spain

Straw

Stalks

Husks

Nuts

Other

Corn pith

Unbaled / harvested
Decorticated
Shredded
Sieved (3 particle sizes)

Granular

Sodium alginate (3-5%)

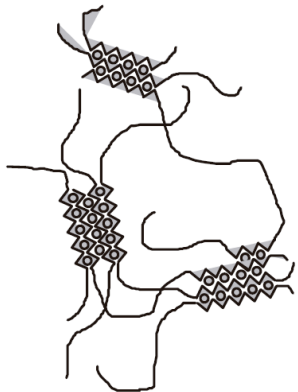Water
Ca^{2+} (calcium sulphate di-hydrate)
Sodium citrate

Corn pith - alginate
Density: 40-60 kg/m^3
Cond: 0.038-0.040 W/mK

Polystyrene
Density: 15-45 kg/m^3
Cond: 0.030-0.040 W/mK

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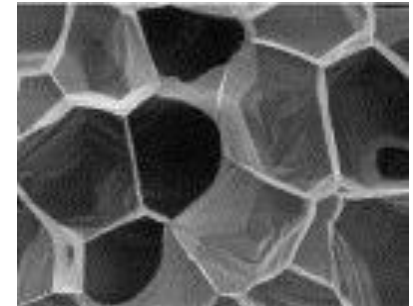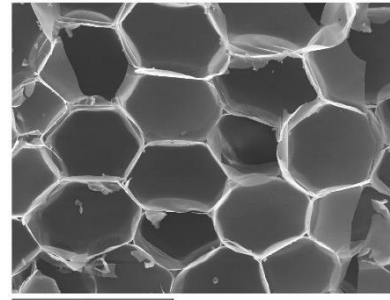
Hygroscopic and thermal properties

Scanning Electron Microscopy SEM
Mercury Porosimetry
Dynamic Vapour Sorption
Electronic Transient Thermal Analyser
Heat Flow Meter
Dynamic hygrothermal test
Moisture Buffering Value

Behaviour in case of fire

TGA
Pyrolysis Combustion Flow Calorimetry
Ignition time and extinguishability
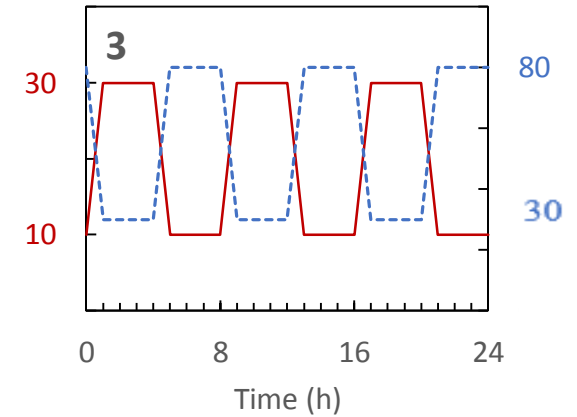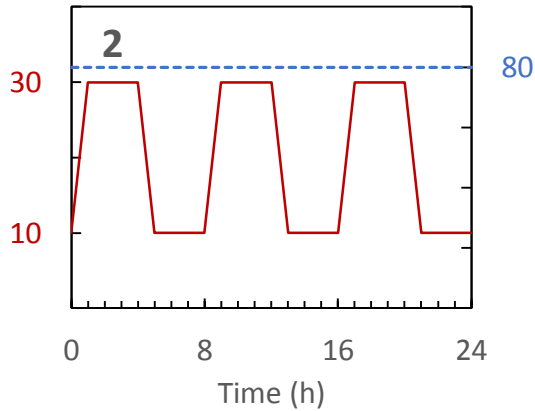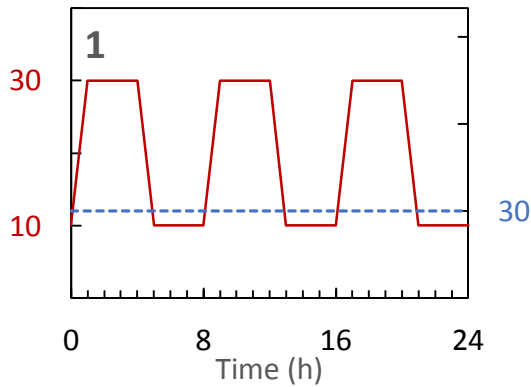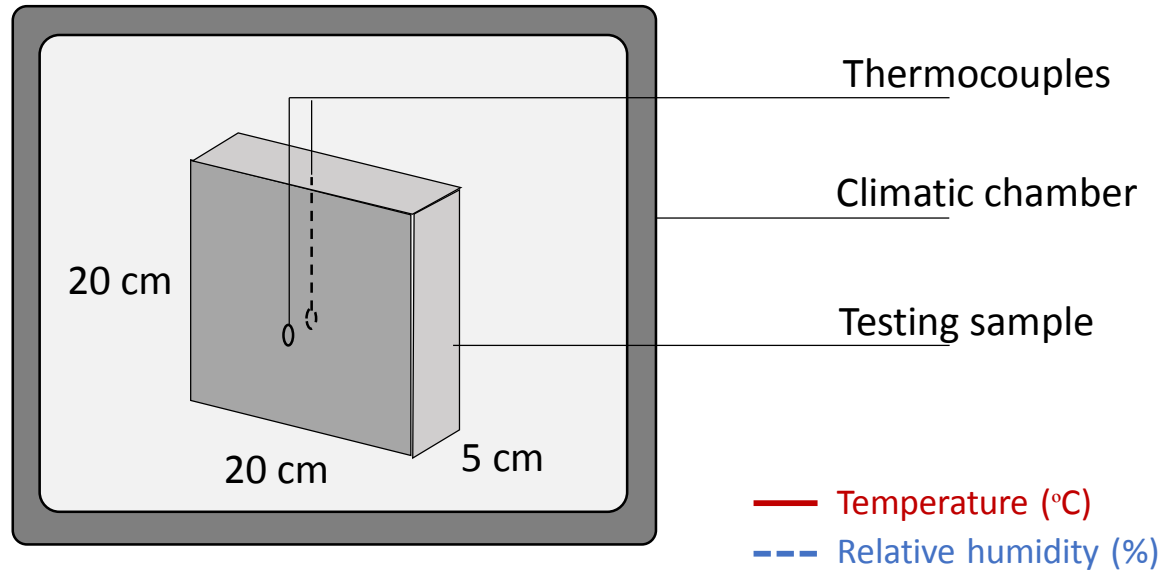Limiting oxygen index LOI
Smouldering combustion

Mould growth resistance

Sealed growing cases

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Dynamic hygrothermal test

Testing especimens:

Polystyrene
Mineral wool
Wood Wool
Corn Alginate

Thermocouples

Climatic chamber

Testing sample

20 cm

20 cm   5 cm

0

—— Temperature (°C)
--- Relative humidity (%)

1

30

10

30

0   8   16   24
Time (h)

2

30

10

80

0   8   16   24
Time (h)

3

30

10

80

30

0   8   16   24
Time (h)

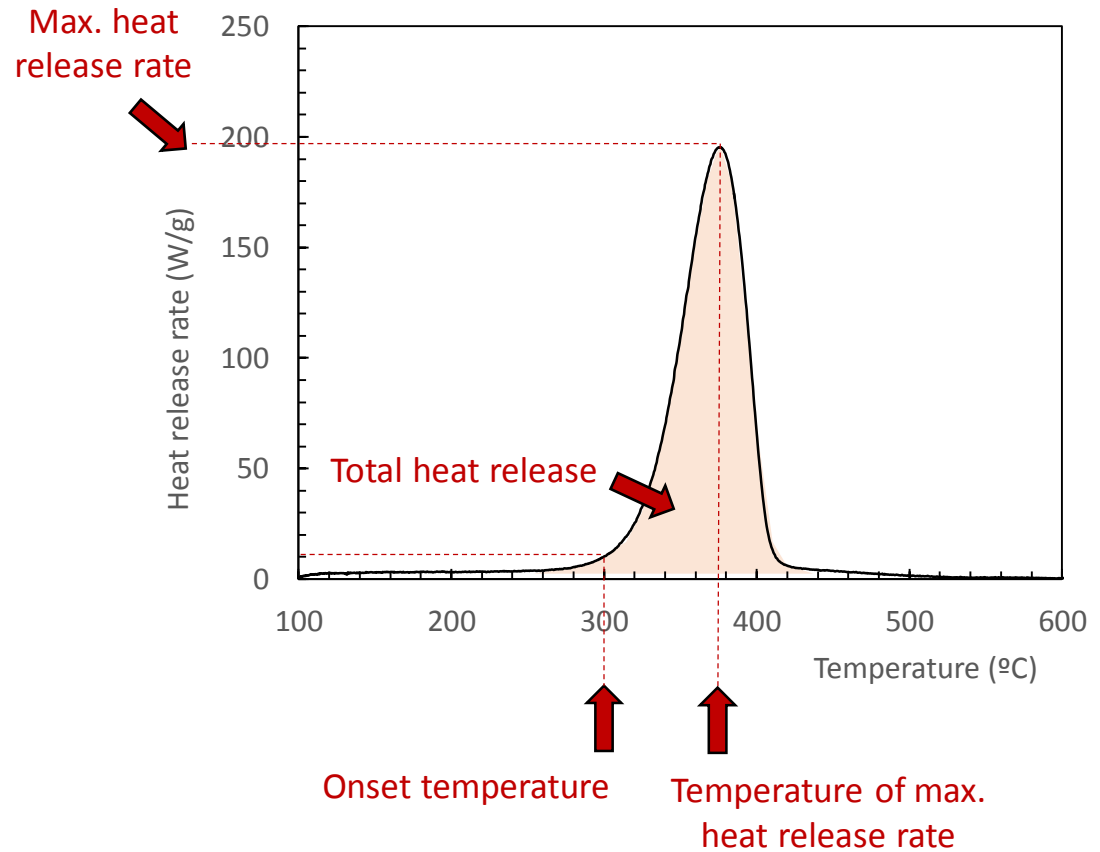Dynamic hygrothermal test
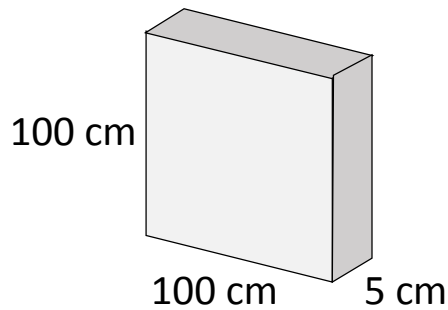

1 RH = 30%   **2** RH = 80%   **3** RH = 30 / 80%
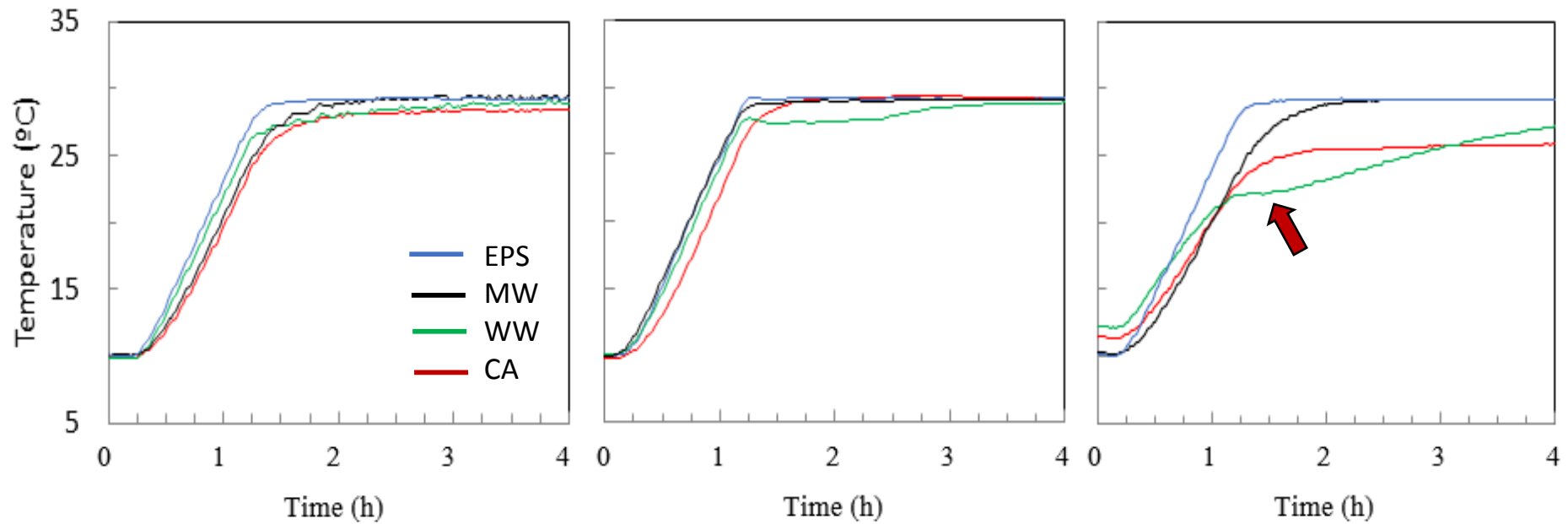
Pyrolysis Combustion Flow Calorimetry

Pyrolysis Combustion Flow Calorimetry

THR = 38.7 MJ/kg

THR = 6.0 MJ/kg

Polystyrene

Alginate
Corn pith
Corn pith + alginate

100 cm

100 cm   5 cm
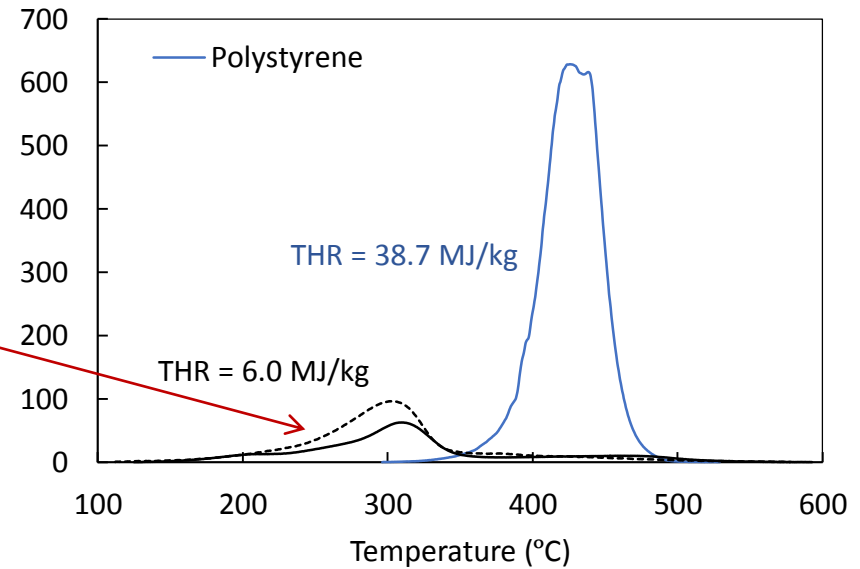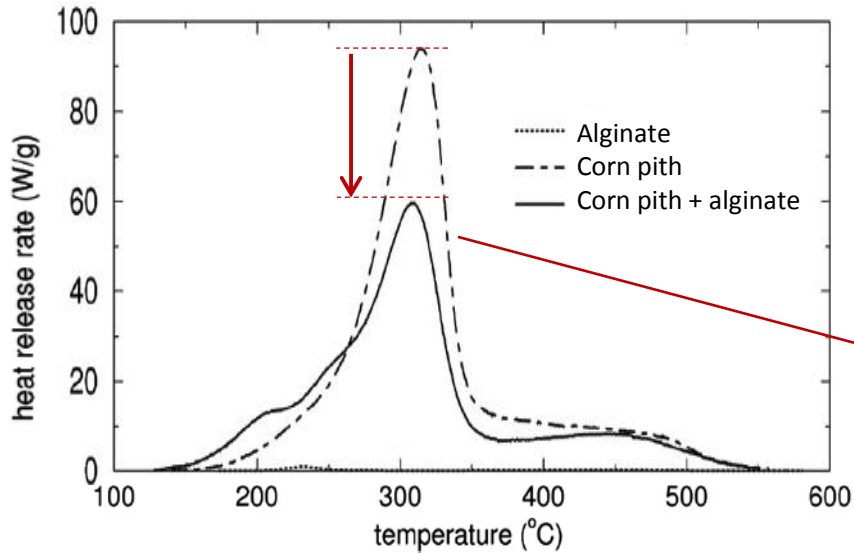
Sample	Density (kg/m³)	Mass (kg)	HR (MJ)
C	55	2.8	20
EPS	30	1.5	60

Smouldering Combustion

On-set temperature for smouldering to occur.

Speed of propagation.

	Additive	(%)
CA	-	-
BAC	Boric acid	8.0
AH	Aluminium hydroxide	8.0
APP	Ammonium polyphosphate	8.0
BAPP	BAC + APP	2.7 + 5.3

Type K thermocouples · Sample holder · Sample · Hot plate · Heating controller
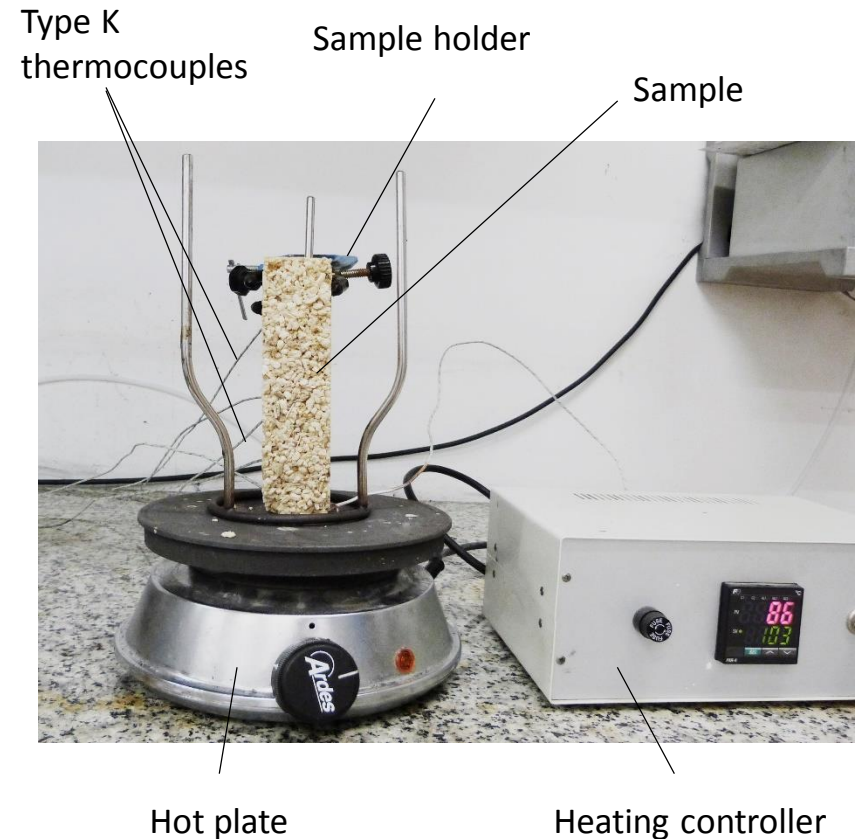
Smouldering Combustion

The initial time is delayed and speed of propagation is reduced in treated samples.

The region at high temperature (white) is less extended in treated samples.

Pre-set temperature: 280ºC

25 min   30 min   35 min   40 min   45 min   50 min

10ºC   400ºC
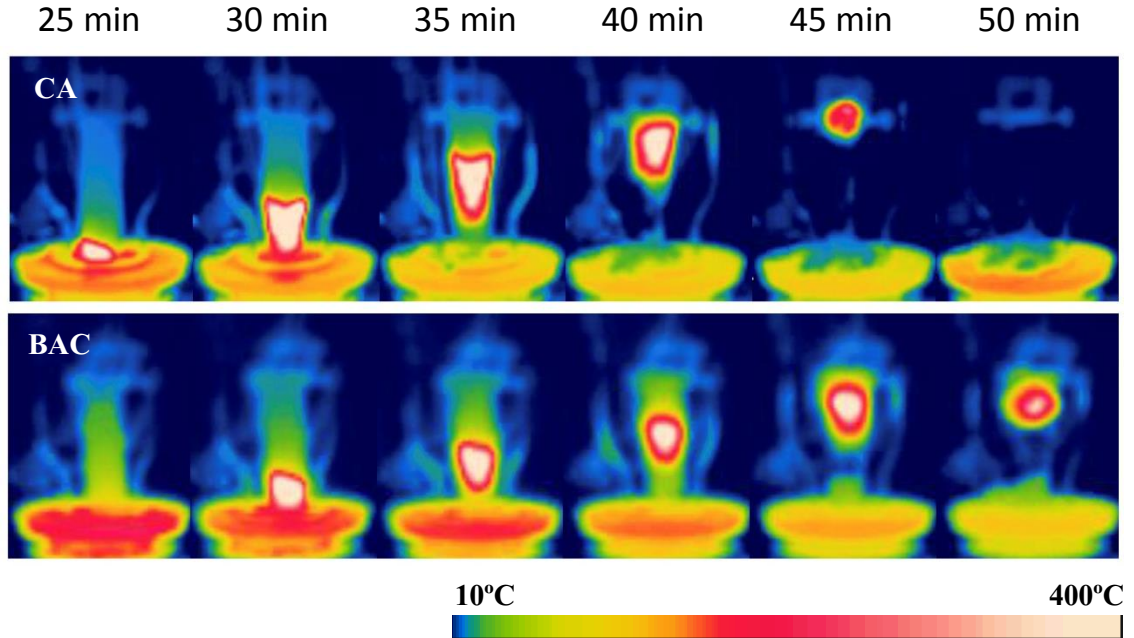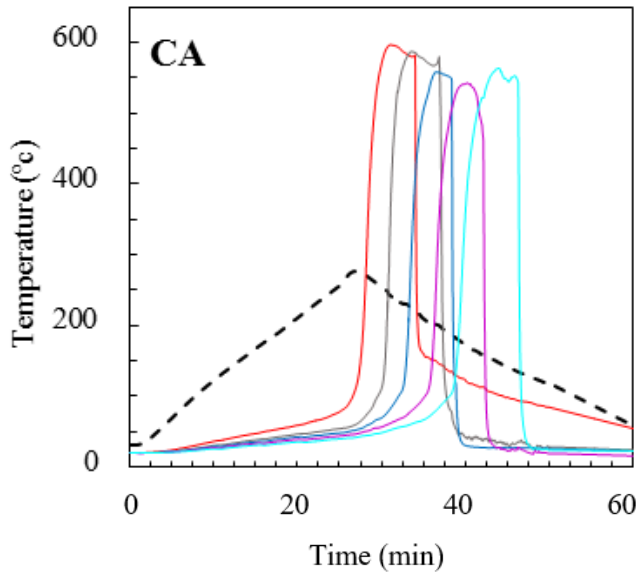
Smouldering

The initial temperature for smouldering to occur is higher in BAPP and APP samples.

In APP samples the speed of propagation is 3 times lower than in plain samples.
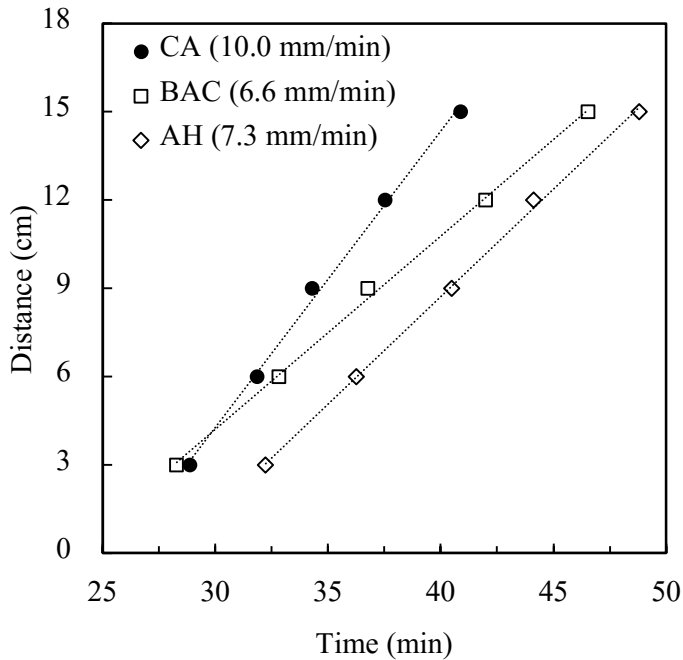

	T_{onset}	Speed at T_{onset}
	(ºC)	(mm/min)
CA	< 280	10.0
BAC	< 280	6.6
AH	< 280	7.3
APP	300	3.6
BAPP	310	5.9
WW	330	10.7

Sealed growing cases

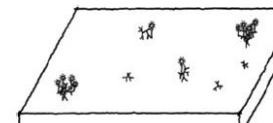| Code	Additive name	% to granulate
C	-	
A	-	
CA	-	
BAC-5	Boric acid	5
BAC-10	Boric acid	10
L-5	Lime (5% solution)	-
L-10	Lime (10% solution)	-
L-20	Lime (20% solution)	-
ST-2	Stearate	2
ST-10	Stearate	10
MT-2	Mimosa tannin	2
MT-10	Mimosa tannin	10
MT-50	Mimosa tannin	50
AT_V	Acetic anhydride	
AT_I	Acetic anhydride	
LG	Lauryl Gallate	
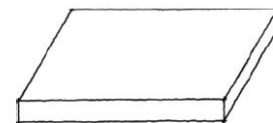
0 = No growth
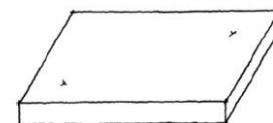
1 = Sparse, initial growth
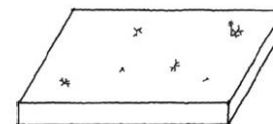
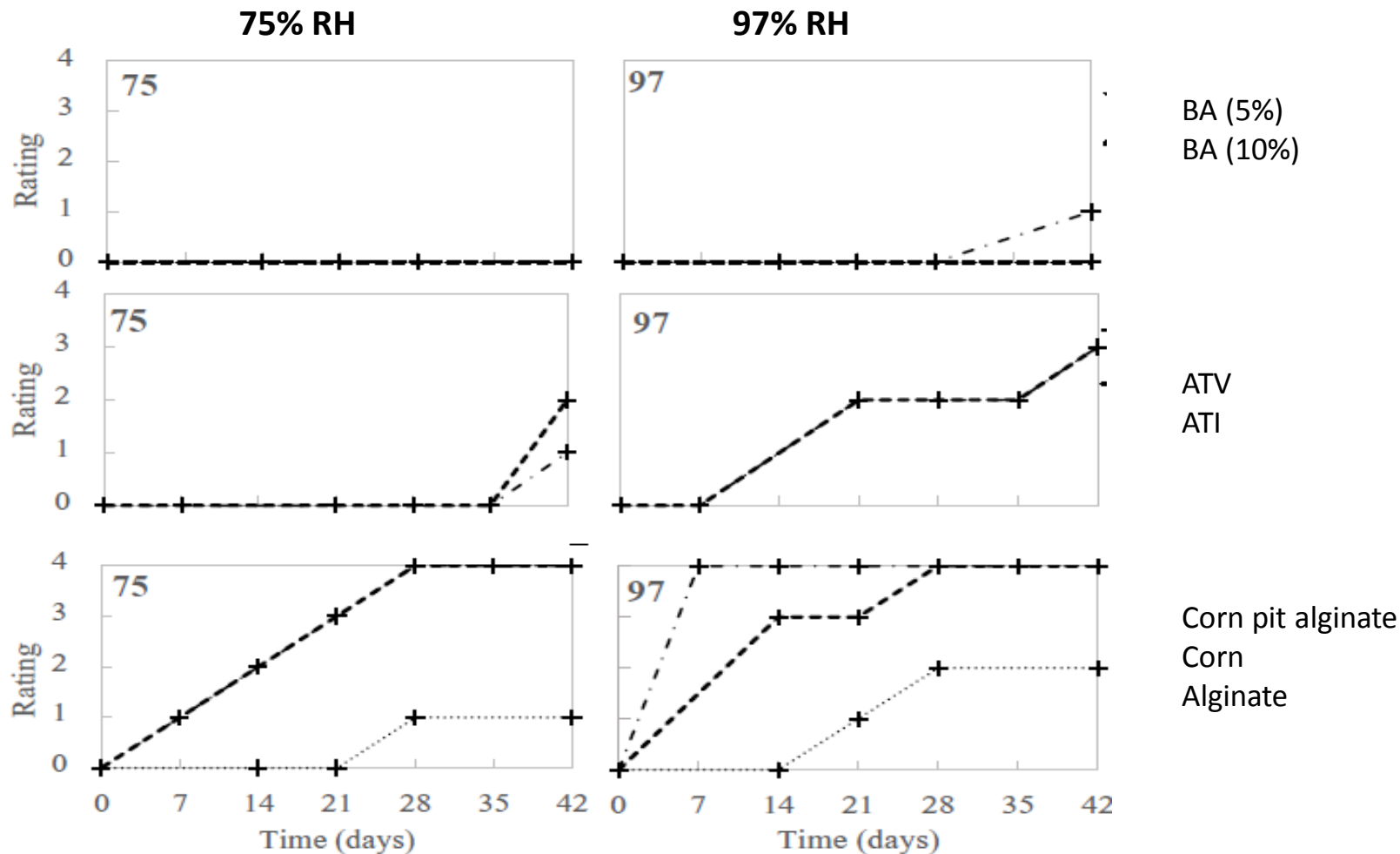**2** = Sparse established growth

3 = Patchy, heavy growth

4 = Growth over most or all of the surface.

Rating scale (from Johansson 2011)

Sealed growing cases

All the tested treatments reduced mould growth. L-20, BA and ST-10 yield the best results

75% RH **97% RH**

BA (5%)
BA (10%)

ATV
ATI

Corn pit alginate
Corn
Alginate

Hygrothermal performance of the material in building systems

Durability

Building systems and products: ETICS, insuflated in cavity walls, light ceiling boards, …

Infinite ready to use optimised designs

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Thank you

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