ECO-PCCM **6th Framework Programme** **European Commission**

Proposal no: INCO-CT-2004-509185

Project acronym: ECO-PCCM

Project full title:
"Eco-houses based on Eco-friendly Polymer Composite Construction Materials"

FINAL ACTIVITY REPORT

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Start date of project: October 1, 2004 Duration: 36 months

Project coordinator name: Maurizio Avella

Project coordinator organization name: ICTP-CNR

(Institute for Chemistry and Technology of Polymers – Italian National Research Council)

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PUBLISHABLE EXECUTIVE SUMMARY

Objectives of the project

The scientific and technological research objectives of ECO-PCCM project are:

- Development of renewable natural fibre composites based on annually grown plant (rice straw, hemp, kenaf, cotton, sisal, flax) and wood (cellulose) fibres and bio-derived renewable polymers (starch based, PLA), suitable for structural applications.
- Application of various forms of plant fibres: short, long, continuous, woven fabrics and non-woven mats and investigation of their influence on 3P (properties/performance/price) ratio.
- Tailoring of the fibre/matrix interactions and interface characterization in GREEN-ECO composites.
- Development of suitable means of connecting panellised natural fibre composite structural components, with an emphasis on ease of assembly and modification during the life of the building.
- Development of panellised components with integral thermal and acoustic insulation for improvement of energy efficiency in eco-buildings.
- Development of appropriate manufacturing technique suitable for rapid industrial application, a wide range of products and optimised low-production costs.
- Pre-industrial prototype realisation and characterization.
- Waste minimization - Reuse and Recycling: Reuse and recycling of thermosetting and thermoplastic based composites by mechanical/thermal treatment. Design of recycling facilities for transformation/conversion of solid-plastic waste into polymer mortars for the low-cost building industry. Development of materials and process that allow an easy deconstruction-recycling-reuse, selective demolition process, methods for recycling-reuse of polymer composite construction wastes, etc.

Partners

Partic. Role	Partic. no	Participant name	Participant short name	Country
CO	**1**	Institute of Chemistry and Technology of Polymers - National Research Council	ICTP-CNR	ITALY
CR	**2**	Cidemco, Centro de investigacion Tecnologica	CIDEMCO	SPAIN
CR	**3**	Mondirect Market, S.L.	MONDIRECT	SPAIN
CR	**4**	Kenaf Eco Fibres Italia	KEFI	ITALY
CR	**5**	Faculty of Technology and Metallurgy, University of Skopje	TMF	R. MACEDONIA
CR	**6**	11 Oktomvri - Eurokompozit	EUROKOMPOZIT	R. MACEDONIA
CR	**7**	Institute of Chemistry, Technology and Metallurgy	ICTM	RS
CR	**8**	Institute for Material Characterisation	USKIM-ZIMRANT	R. MACEDONIA
CR	**9**	Studio R Design, construction, engineering	STUDIO R	R. MACEDONIA
CR	**10**	Ministry of Environment and Physical Planning	MOEPP	R. MACEDONIA
CR	**11**	Geonardo Environment Technologies	GEONARDO	HUNGARY
CR	**12**	Institute of Polymers, Bulgarian Academy of Sciences	IPBAS	BULGARIA

Coordinator contact details

Dr. Maurizio Avella

ICTP-CNR

Institute of Chemistry and Technology of Polymers of the Italian Natinal Research Council

Via Campi Flegrei 34, Comprensorio Olivetti, 80078 Pozzuoli (NA) - ITALY

Tel: +39 081 8675058, Fax: +39 081 8675230

e-mail: mave@ictp.cnr.it

Work performed

The WPs of the ECO-PCCM project and the main tasks are listed as follows.

WP1. Development of renewable eco-friendly composites suitable for structural components - Lead contractor: Partner n 1 – ICTP-CNR

T1.1. Development of renewable eco-friendly composites

T1.2. Application of various forms of plant fibres and their influence on 3P (price/properties/performance) ratio

T1.3. Tailoring of the fibre/matrix interactions and interface characterization in eco-composites

WP2. Design and processing of panellised natural fibre composite structural components and suitable means for their connecting - Lead contractor: Partner n 2 – CIDEMCO

T2.1 Design of panellised natural fibre composite structural components

T2.2 Processing of panellised natural fibre composite structural components

WP3. Development of panellised components with integral thermal and acoustic insulation for improvement of energy efficiency in eco-buildings - Lead contractor: Partner n 11 – GEONARDO

T3.1 Achievement of panels with high thermal and acoustic properties

T3.2 Development of methods for the assessment and the optimisation of housing comfort

WP4. Development of appropriate manufacturing technique suitable for rapid industrial application, a wide range of products and optimized low-production costs - Lead contractor: Partner n 6 – EUROKOMPOZIT

T4.1 Development of appropriate manufacturing technique suitable for rapid industrial application

WP5. Waste minimization – Reuse and Recycling - Lead contractor: Partner n 5 – TMF

T5.1 Development and design of recycling-reuse facilities

T5.2 Methods-guidelines for the waste minimization

T5.3 Development of materials and process for an easy deconstruction-recycling-reuse, selective demolition of eco-houses

WP6. Project Management - Lead contractor: Partner n 1 – ICTP

T6.1 Management

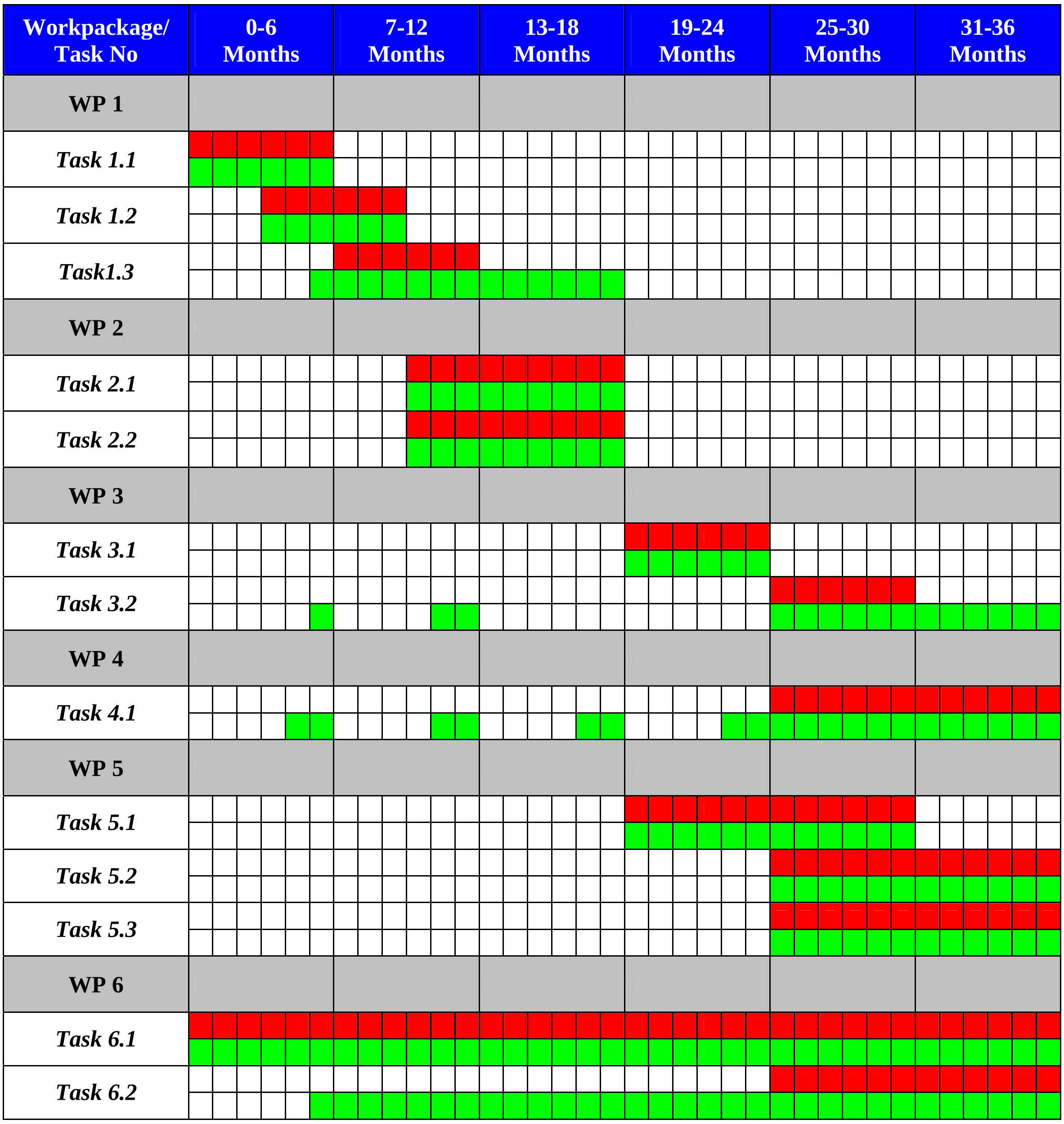
T6.2 Exploitation

During the three years of the ECO-PCCM project, all the WPs were completed according to the following Gant chart.

Details of the activities are reported in the Section 1.

Gant chart of the project

Table 1. Gantt chart of the project including the workpackages and the tasks



Legend

Planned activities	
Realised activities	
Extended activities	

Project logo

Project website

The ECO-PCCM website can be found at http://elchem.ihtm.bg.ac.yu/ECO-PCCM/

Section 2 - WP ACTIVITIES

WP1 Development of renewable eco-friendly composites suitable for structural components

Lead contractor: Partner n 1 – ICTP-CNR

Workpackage objectives

a) Development of renewable natural fibre eco-friendly composites;
b) Application of various forms of plant fibres and their influence on 3P (price/performance/properties) ratio
c) Tailoring of the fibre/matrix interactions and interface characterization in eco-composites.

The tasks planned for WP1 are briefly reported as follows:

T1.1: Development of renewable eco-friendly composites

T1.2: Application of various forms of plant fibres and their influence on 3P (price/properties/performance) ratio

T1.3: Tailoring of the fibre/matrix interactions and interface characterization in eco-composites.

WP1. has been completed with the II year of the project

Progress towards objectives

T1.1: Development of renewable eco-friendly composites

The development of environmental friendly polymer composite materials reinforced with renewable natural fibres based on annually grown plant (rice straw, hemp, cotton, sisal, flax) and wood (cellulose) fibres and bio-derived renewable polymers (starch based, PLA), suitable for structural applications, was the key objective of the task 1.1.

Partners 1, 2, 4, 5, 7 and 12 have worked on this task in order to develop environmental friendly composite material based on natural fibres and appropriate polymer matrix. Among the partners, it was decided to use polypropylene (PP) as a referent thermoplastic matrix for NFC in order to compare the properties of new eco-friendly composite materials with commonly used thermoplastic.

To realise the eco-polymer composites, partners have evaluated several polymeric matrices and fibres from annually grown plants and wood. In the following table the composition (polymeric matrices and natural fibres) of the composite system are summarized :

Table 1. Polymeric matrices and natural reinforcements from annually grown plants and wood evaluated for the realisation of eco-composites

POLYMERS
Polyhydroxybutyrates (PHB)
Polyhydroxybutyratevalerate (PHBV)
Poly(lactic acid) (PLA)
Polypropylene (PP, reference)
Polyethylenterephtalate (PET, reference)

NATURAL REINFORCEMENTS
Rice straw
Hemp
Jute
Sisal
Cellulose (recycled paper)
Kenaf

Eco-friendly polymer composite samples (different matrices, fibres and fibre contents) have been submitted to several sets of characterisations. The characterisation protocol has been established defining the samples shape and dimensions, and defining the procedure to be used by the different partners involved in the characterisation task.

Characterization protocol of the natural fibres, polymer matrices and eco-composites includes standard procedures commonly applied for these materials. The following methods have been selected for the analysis of mechanical, thermal, structural and interface properties of the investigated materials: mechanical properties (tensile, flexural, impact), abrasion resistance, DMTA, DSC, TGA, WAX, FTIR, SEM.

To avoid the possible conflict that could arise by using different characterisation conditions (applied, for the same technique, by different partners), unified procedures have been established and agreed among the partners.

Tensile tests were performed on dumb-bell specimens by using Instron machines (partners 1, 2) at room temperature and a cross-head speed of 10 mm/min (average 10 samples tested).

Flexural tests were performed on rectangular-shaped specimens by using Instron machines (partners 1, 2) at room temperature and a cross-head speed of 2 mm/min (average 10 samples tested).

Impact tests were performed with an instrumented Charpy pendulum (Ceast Autographic Pendulum MK2) at a room temperature and at an impact speed of 1 m/s. For this test the samples (in the form of small bars with dimensions 6.5 x 0.6 x 0.3) were notched with a fresh razor blade, ~ 0.2 mm depth. The final value of notch depth was measured after fracture by using an optical microscope. The impact properties were analysed according to the linear elastic fracture mechanism (LEFM) approach.

Abrasion resistance tests were carried out using a Taber type 5130 abrader (partner 2). The dimensions of the square sample specimens were 5 x 10 x 10 cm. The abrasive paper, grain 80, was applied on the Teflon rollers of the machine. The applied weight of the arms was 1000 g. Three sessions of 500 cycles were performed on the samples. Abrasion resistance was evaluated as the loss of samples weight.

DMTA data were collected on different equipments (partners 1, 5) at a heating rate of 3°C/min. The experiments were performed in bending and tensile modes depending upon the nature of the samples.

DSC analysis was performed on different differential scanning calorimeters (partners 1, 5, 12) at different scanning rates depending upon the purposes of the measurements. Dry nitrogen gas with a flow rate of 20 ml/min was purged through the cells during all measurements and thermal treatments.

TGA was performed on different TG equipments (partners 1, 5) by recording the weight loss as a function of temperature. The samples were heated from 30°C to 700°C at a scanning rate of 10°C/min in nitrogen atmosphere. The degradation temperature (Td) was taken as the temperature corresponding to 50% loss of the initial mass.

Wide-angle X-ray scattering (WAX) (partner 7) data were collected on a Philips PW 1510 diffractometer (U = 38 kV, I = 20 mA), with curved graphite monochromator, using

Cu $K\alpha$ radiation (λ = 1.5418 Å) and step-scan mode (2θ-range: 8-30°). Scan time and step were 5 s and 0.05 º2θ, respectively. Before data collection, the samples (m » 0.2 g) were slightly pressed (5 MPa) in pellets of 20 mm diameter.

Fourier Transform Infrared Microscopy (Micro-FTIR) were recorded by means of a Perkin Elmer AutoIMAGE FT-IR Microscope System - Spectrum GX and 2000 (partners 1, 5). The microscope was used both in reflection and transmission mode, with 300 scans recorded for each spectrum and a nominal resolution of 4 cm^{-1}.

SEM analysis was performed by using a scanning electron microscopes (partners 1, 7) on cryogenically fractured surfaces. Before the observation, samples were metallized with a gold coating.

From the preliminary investigations of different natural fibres for eco-friendly composites kenaf fibres have been selected for their peculiar characteristics: diameter 5-30 µm, stress at break 350-600 MPa, strain at break 2.5-3.5 %, modulus 40-45 GPa, density 1500 kg/m^3, amount of cellulose 75-90%.

The literature survey made by the partners 1 and 5 and the preliminary results of testing have been already exploited through the preparation of papers submitted to the journals Polymer Composites and Polymer International, as well as through presentations at conferences.

T1.2: Application of various forms of plant fibres and their influence on 3P (price/properties/performance) ratio

To simplify the production process of eco-composite materials and also to reduce the production costs, commingled technique has been selected for blending the reinforcing fibres with polymer matrix.

Polymer matrices used to produce composite preforms are also in the form of fibre, which should provide good homogeneity and wetting of the reinforcing component during the further process of consolidation.

The composite preforms were produced by partner 4 as non-woven (webs) and delivered to partners 1, 2 and 5 for further analysis.

Several characterization methods have been used to investigate the main properties of the preforms (kenaf/PLA and kenaf/PP with different fibre/polymer ratio) as follows:

- Density (EN 1602:1997)
- Fire tests (ISO 11925-2:2002)
- Water absorption (EN 12087:1997)
- Water steam absorption (EN 12086:1997)
- Dimensional stability (EN 1604:1996)
- Tensile tests parallel to the faces (EN ISO 527-3:1996)
- Tensile tests perpendicular to the faces (EN 1608:1997)

Also, the influence of fibre length distribution on the final properties of the preforms was investigated.

Based on the obtained results of testing several conclusions have been derived:

- High density materials show better fire and tensile performance but slightly less water steam resistance,
- High density materials behave as good as other insulating materials for construction regarding water absorption and tensile tests.

Besides the experiments carried out with natural fibres as reinforcements, rice straw (20, 30% wt) has been used to prepare composite materials with PLA, PHBV and PP (as reference), applying extrusion and compression moulding techniques. Rice straw used is a waste product from the rice production in Macedonia, kindly supplied by Rice Institute from Kocani, Macedonia. The obtained preliminary results for mechanical properties of rice straw based composites have confirmed that rice straw (RS) can be used as eco-friendly reinforcement with all polymer matrices. For instance, tensile modulus (E) of RS/PP composite, containing 30% RS exhibit modulus of 1,51 GPa (E_{PP}=0,91 GPa), while the thermal stability was also slightly increased as compared to neat PP.

The main results and conclusions from the task 1.2 of WP1 are already prepared for presentation on conferences/congresses (see exploitation part in the Consortium Management Section).

T1.3: Tailoring of the fibre/matrix interactions and interface characterization in eco-composites

The performance of fibre reinforced composite materials strongly depend on fibre/matrix interface, which determines stress transfer and significantly influences the overall mechanical properties of the composite. For this reason special attention has been paid on improvement of compatibility and adhesion phenomena in the investigated systems.

Two different approaches have been applied to fulfil the task 1.3:

A) modification of natural fibres chemistry and morphology;

B) application of coupling agents during mixing of composite components.

In particular in the following table the list of the cellulose fibre samples treated by chemical modification (approach A) is reported, together with the techniques used to carry out their characterization.

Table 2. Selected fibres, chemical treatments carried out, techniques used for characterization of the surface-modified fibres, and partners involved

Sample	**Surface chemical treatment / characterization technique**	**Partners involved**
Kenaf fiber	Dewaxing / FTIR, SEM, POM, WAX	TMF, ICTM, ICTP,
Kenaf fiber	Mercerization / FTIR, SEM, POM, WAX	TMF, ICTM, ICTP,
Kenaf fiber	Acetylation with acetic anhydride / FTIR, SEM, POM, WAX	TMF, ICTM, ICTP,
Kenaf fibre	Experiments on surface graft copolymerization onto kenaf / FTIR, SEM, POM, WAX	TMF, ICTM, ICTP,
Juta fibre	Dewaxing / FTIR, SEM, POM	TMF, ICTM
Juta fiber	Mercerization / FTIR, SEM, POM	TMF, ICTM
Sisal fiber	Dewaxing / FTIR, SEM, POM	TMF, ICTM
Sisal fibre	Mercerization / FTIR, SEM, POM	TMF, ICTM

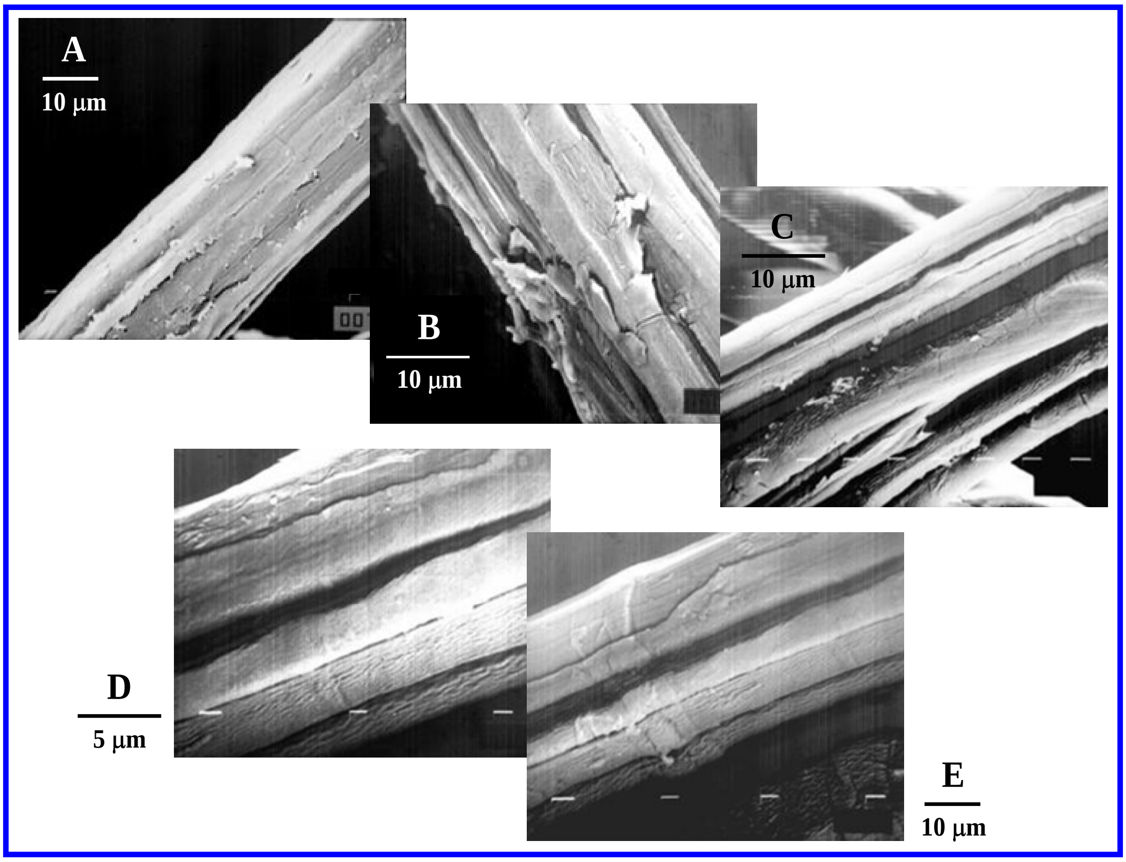


Figure 1. SEM micrographs of kenaf fibres: A) untreated; B), C), D), E) alkali treated

The results of SEM analysis have shown that surface morphology of the fibres changes with gradual removal of non-cellulosic constituents (like lignin and hemicellulose) caused by alkali treatment.

Surface modification of kenaf fibres has induced structural changes as it was shown by WAX diffraction patterns, shown on figure 2 and table 3. Diffraction patterns of treated kenaf fibres are typical for cellulose I, although additional maxima at about 25° of 2θ are also observed (see Figure 2, curves B, C, and E).

The most significant changes in crystalline structure are observed after alkali treatment of kenaf fibres that have induced an increase of crystallinity as well as in crystallite size.

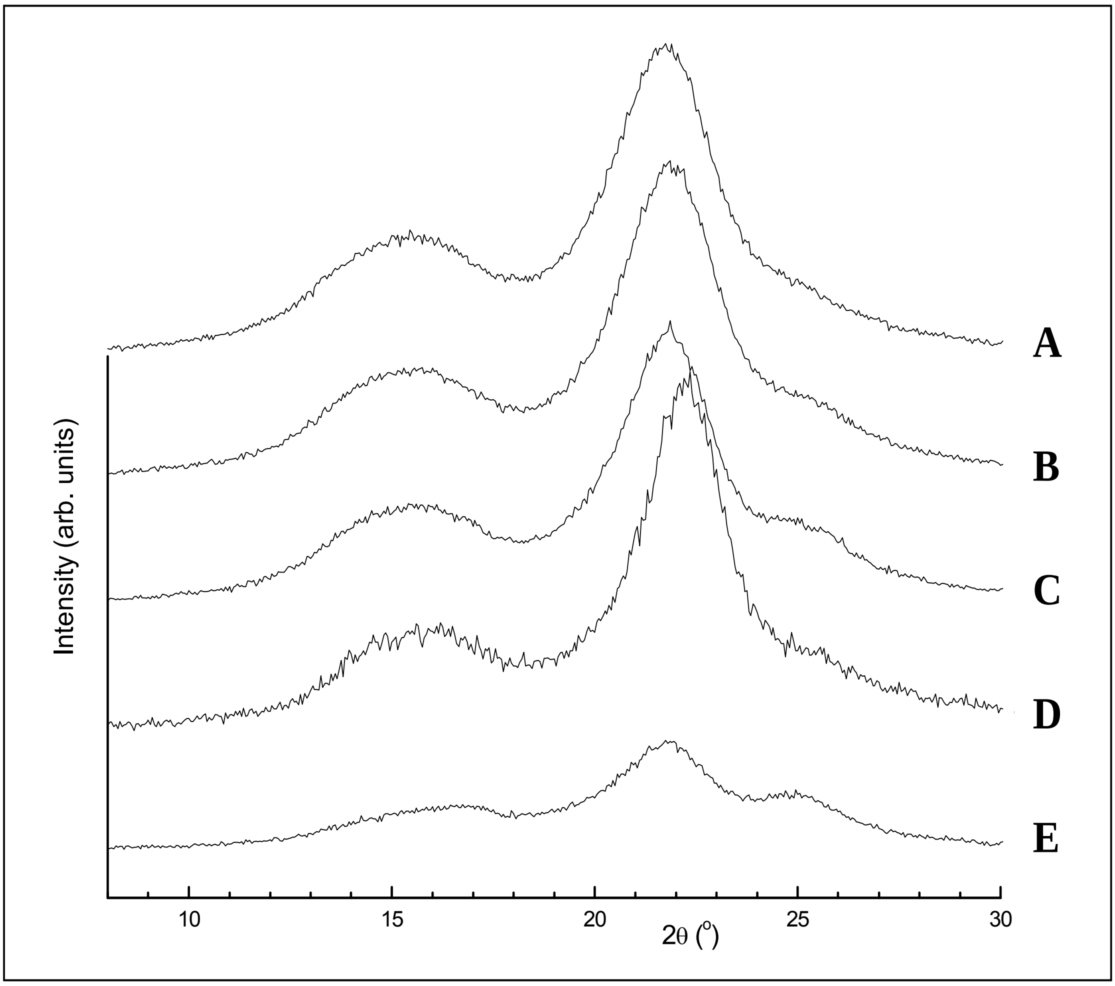


Figure 2. WAX patterns of different kenaf samples:
A) untreated; B) dewaxed; C) ACN-grafted; D) alkali treated; E) acetylated

Table 3. WAX data of kenaf fibres modified samples

Samples		Integral crystallinity (%)	Crystallite size (Å)		
			D(101)	D(10-1)	D(002)
1	Untreated	70	28	45	37
2	Dewaxed	75	30	49	39
3	ACN-grafted	75	28	47	40
4	Alkali treated	77	34	40	45
5	Acetylated	67	-	-	41

As far as the improvement of interfacial adhesion, carried out through coupling agent based methods (approach B), preparation and characterization of coupling agent was studied by partner 1. PHBV and PLA were modified by grafting different amount of maleic anhydride (MA: 3, 5 and 7 wt%) onto PHBV (figure 3) and PLA backbones.

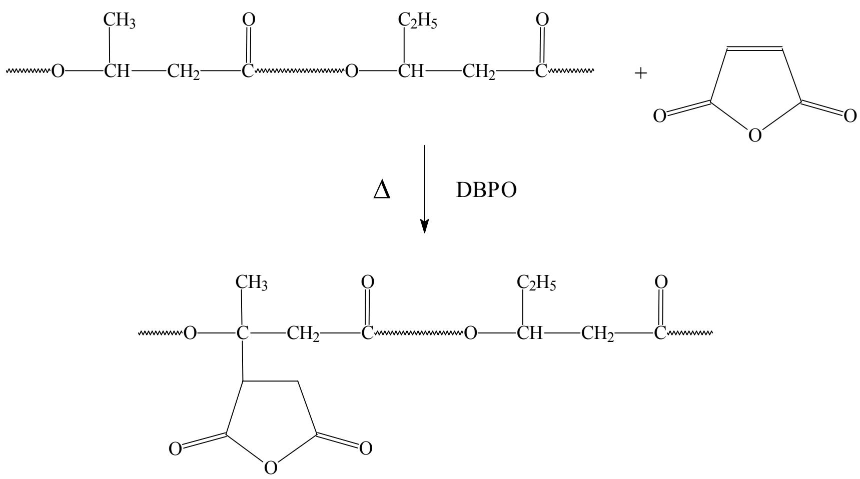


Figure 3. Grafting of maleic anhydride onto PHBV

Grafted PHBV and PLA were analyzed by FTIR and viscosimetric analysis. The obtained FTIR spectra are presented in the figure 4, while the viscosimetric data are presented in table 4 and 5. As itt was expected, the presence of carboxyl units promote ester-exchange reactions with significant decreases of the polyester MW.

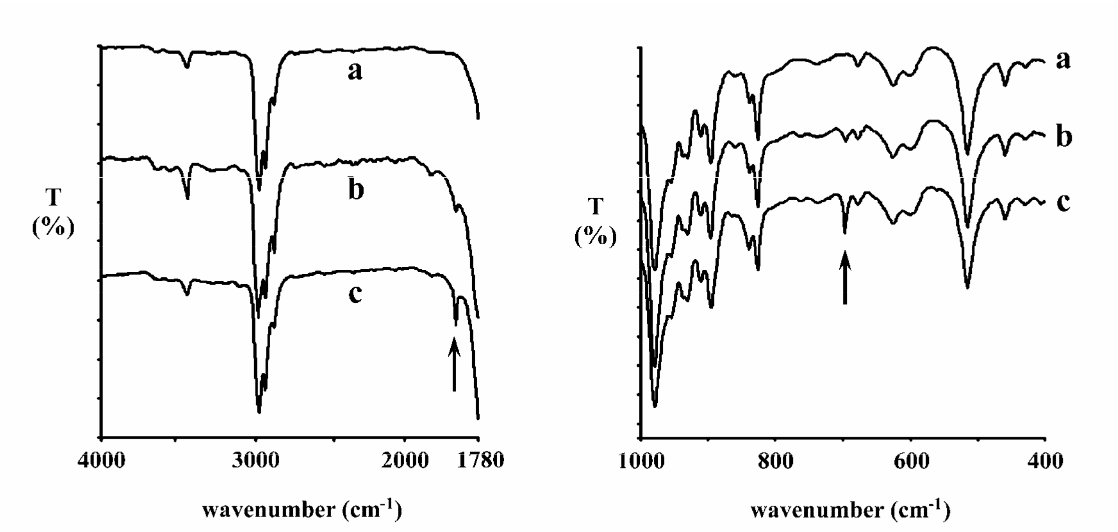


Figure 4. FTIR spectra of neat and grafted PHBV:
a) neat PHBV; b) MA 3 wt%; c) MA 7 wt%

Table 4. Viscosimetric data of grafted PHBV

MATERIALS	MW (Da)
PHBV neat	123000
PHBV processed	116000
3 wt% MA	112000
5 wt% MA	96000
7 wt% MA	77000

K = 0.012 mL/g; α = 0.77

Table 5. Viscosimetric data of grafted PLA

MATERIALS	MW (Da)
PLA neat	118000
PLA processed	111000
3 wt% MA	106000
5 wt% MA	101000
7 wt% MA	93000

K = 0.022 mL/g; α = 0.81

The obtained coupling agents were mixed in a Brabender-like apparatus together with the corresponding neat matrices and with kenaf fibers (reactive blending) at the following conditions: temperature 180°C, time 10 min , mixing rate up to 32 rpm

Two different compositions were prepared:

- Matrix 65 wt% kenaf 30 wt% CA 5 wt%
- Matrix 75 wt% kenaf 20 wt% CA 5 wt%

The composites prepared with modified matrix were characterized by DMTA, TGA, SEM and mechanical analysis. Main results are presented in figures 5, 6 and 7 and in tables 6, 7 and 8.

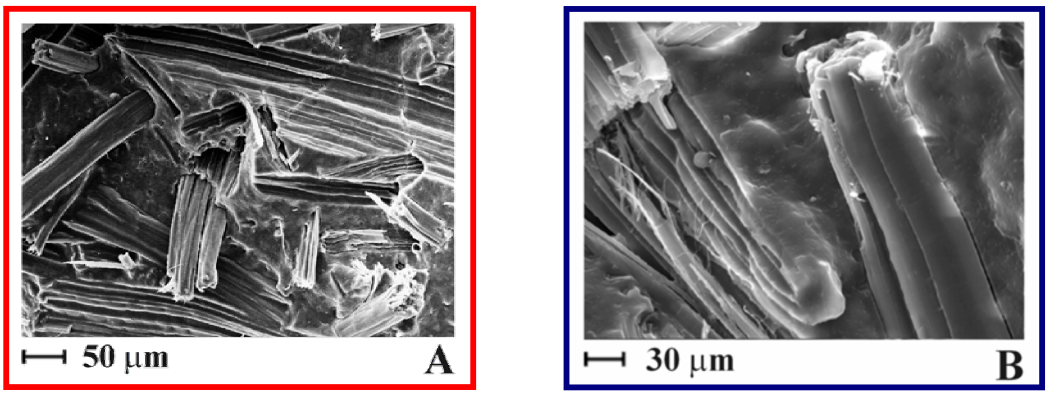


Figure 5. SEM of PHBV/Kenaf composites
A) uncompatibilized PHBV/kenaf 70/30 wt%, B) PHBV/kenaf/CA 65/30/5 wt%

Table 6. DMTA data for PHBV based composites

Materials	E' -40°C (MPa)	E' +40°C (MPa)	E'' -40°C (MPa)	E'' +40°C (MPa)	Tg (°C)
PHBV neat	3062	879	124	29	2.9
PHBV/K 80/20	3237	1347	137	59	4.7
PHBV/K 70/30	3554	1558	156	67	4.7
PHBV/CA/K 75/5/20	4091	1867	176	77	8.6
PHBV/CA/K 65/5/30	4584	2205	209	92	8.5

Table 7. Mechanical results for PHBV/Kenaf composites

Materials	Flexural Properties		Impact properties
	Stress at maximum load (MPa)	Young's Modulus (MPa)	Resilience (kJ/m2)
PHBV neat	13	1067	2.7
PHBV/K 80/20	17	1812	3.3
PHBV/K 70/30	18	2214	3.5
PHBV/CA/K 75/5/20	17	2435	3.3
PHBV/CA/K 65/5/30	19	2788	3.9

Table 8. Mechanical results for PLA/Kenaf composites

Materials	Flexural Properties		Impact properties
	Stress at maximum load (MPa)	Young's Modulus (MPa)	Resilience (kJ/m2)
PLA neat	31	3550	1.2
PLA/K 80/20	32	4630	1.6
PLA/K 70/30	37	5230	2.2
PLA/CA/K 75/5/20	37	4830	2.3
PLA/CA/K 65/5/30	38	5200	2.7

Compatibilized PHVB/kenaf and PLA/kenaf composites show higher mechanical improvements with respect to uncompatibilized composites. The compatibilization strategy improves matrix/fibers interfacial adhesion, as confirmed both by morphological and DMTA analyses as well as by the evaluation of the adhesion parameter.

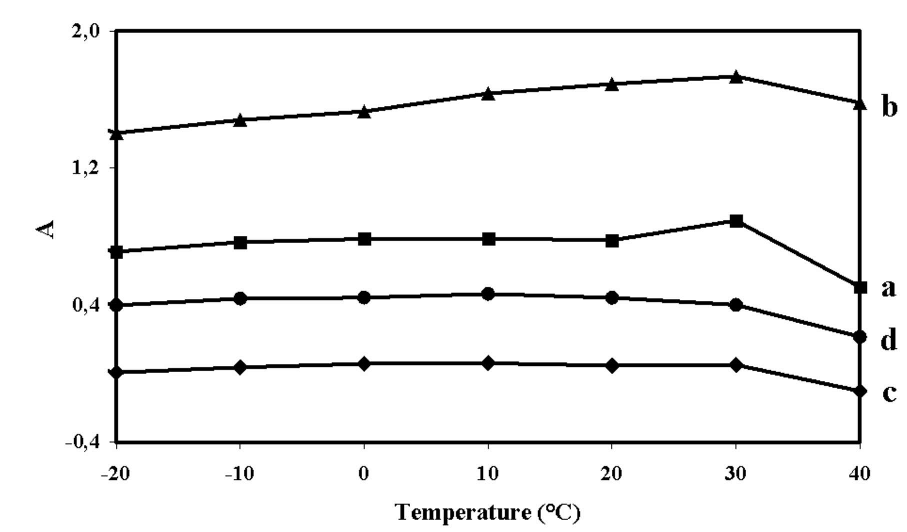


Figure 6. Adhesion parameter for PLA/Kenaf composites
a) PLA/K 80/20, b) PLA/K 70/30 c) PLA/CA/K 75/5/20 d) PLA/CA/K 65/5/30

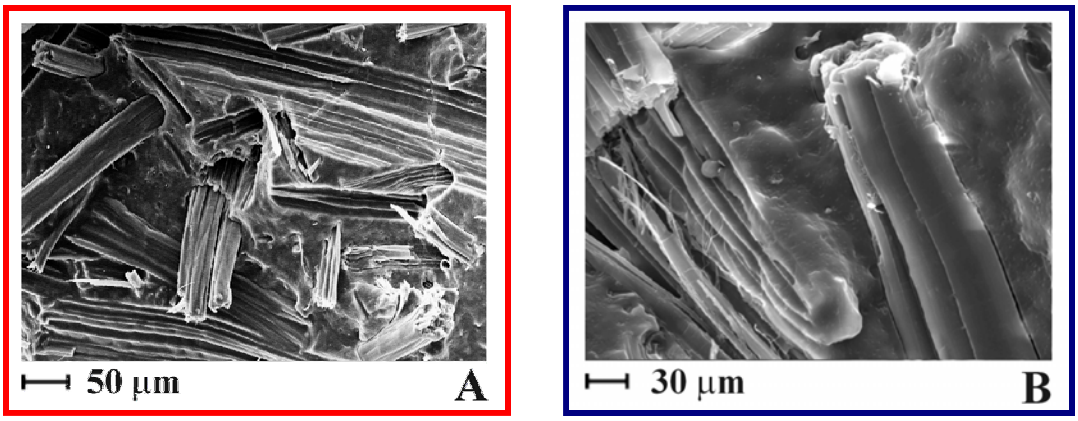


Figure 7. SEM of PLA/Kenaf composites
A) Un-comp PLA/kenaf 70/30 wt%, B) PLA/kenaf/CA 65/30/5 wt%

Also, during the the ECO-PCCM project, an attempt was carried out to use milled rice straw filler in order to improve the natural filler dispersion and the homogeneity of the eco-composites. The obtained results showed improved mechanical behavior for all analyzed systems, PP/Rice straw and PLA/Rice straw composites (see figure 8).

Figure 8. PP/RS/CA and PLA/RS/CA composites

In the following tables the results of the mechanical properties as well as the results of other characterization of the eco-composites with coupling agent (CA) and milled rice straw are reported. For PP based composites, the applied coupling agent was Questron KA 805 by Montell. Rice-straw/Polypropylene (RS/PP) composites of different rice-straw content (20/80, 30/70 wt%) and 5 wt% of CA were prepared by a two-steps procedure: extrusion (HAAKE RHEOCORD, 100 rpm, 165°C) and compression molding (Carver Press, T= 170°C, P= 50-150 bar). Before the extrusion, rice-straw was milled and vacuum-dried for 24 h.

Table 9. Tensile data for PP/RS and PLA/RS composites with and without coupling agent

SAMPLE	Stress at peak [MPa]	Strain at peak [%]	Young modulus [MPa]
PP	33,3	451	1013
PP/RS (80/20)	19,7	4,0	1548
PP/RS/CA (75/20/5)	22,4	3,6	1545
PP/RS (70/30)	18,6	3,5	1690
PP/RS/CA (65/30/5)	22,7	3,8	1779
PLA	49,3	3,2	2072
PLA/RS (80/20)	17,9	1,4	2592
PLA/RS/CA (75/20/5)	16,5	1,5	2610
PLA/RS (70/30)	10,3	1,0	2780
PLA/RS/CA (65/30/5)	26,7	1,7	2757

The application of the coupling agent and the increased rice-straw content resulted in higher tensile modulus, *E*, for both the analyzed composites, based on PP and PLA matrix. However, tensile strength was reduced of about 20% by increasing the rice-straw content. Obviously, at higher rice straw content, the interfacial area between the filler and the polymer also increases, thus reducing the interfacial adhesion between rice-straw (hydrophilic) and polypropylene (hydrophobic). For irregular shape reinforcements, the strength of the composites decreases due to the inability of the reinforcement to support stress transfer from the polymer matrix.

The same trend was recorded for other mechanical properties, such as flexural modulus (table 10) and impact resistance (table 11).

Table 10. Flexural modulus of PP/RS and PLA/RS composites

SAMPLE	Stress at peak [MPa]	Flexural Modulus [MPA]
PP	51,5	1081
PP/RS (80/20)	41,4	1342
PP/RS/CA (75/20/5)	36,7	1389
PP/RS (70/30)	31,4	1451
PP/RS/CA (65/30/5)	41,6	1646
PLA	32,0	2416
PLA/RS (80/20)	18,1	2881
PLA/RS/CA (75/20/5)	22,8	3000
PLA/RS (70/30)	12,4	3034
PLA/RS/CA (65/30/5)	26,8	3031

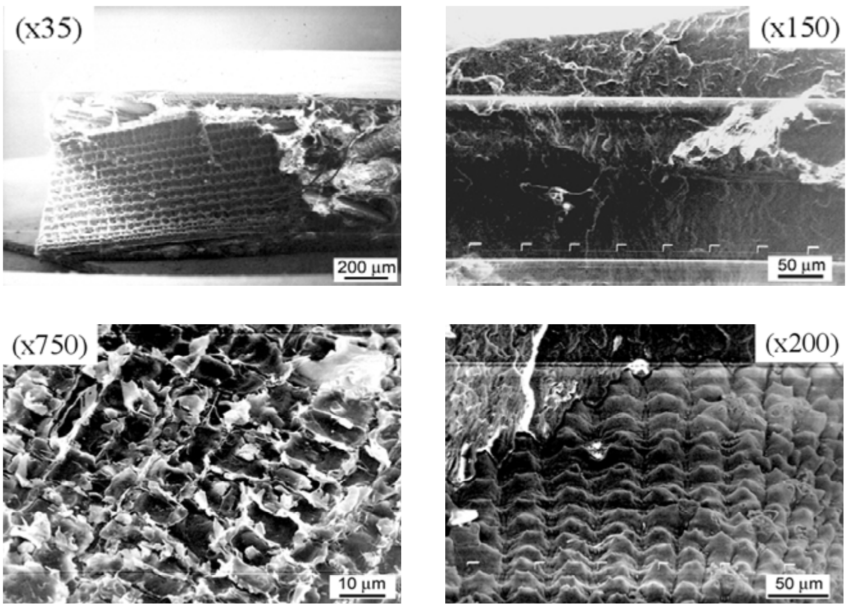


Figure 9. SEM micrographs of PP/RS/CA (75/20/5 wt%) composites

Table 11. Impact resistance of PP/RS and PLA/RS composites

SAMPLE	K_{cI}, [MN-3/2m]	G_{cI}, [KJ/mm2]	R* [KJ/m2]
PP	1,90	2,83	1,42
PP/RS (80/20)	2,08	4,00	1,98
PP/RS/CA (75/20/5)	2,05	3,01	1,49
PP/RS (70/30)	1,90	3,78	1,88
PP/RS/CA (65/30/5)	1,90	3,11	1,57
PLA	2,22	2,69	1,33
PLA/RS (80/20)	1,75	1,59	0,76
PLA/RS/CA (75/20/5)	1,60	1,60	0,86
PLA/RS (70/30)	1,24	1,15	0,58
PLA/RS/CA (65/30/5)	2,05	2,01	1,01

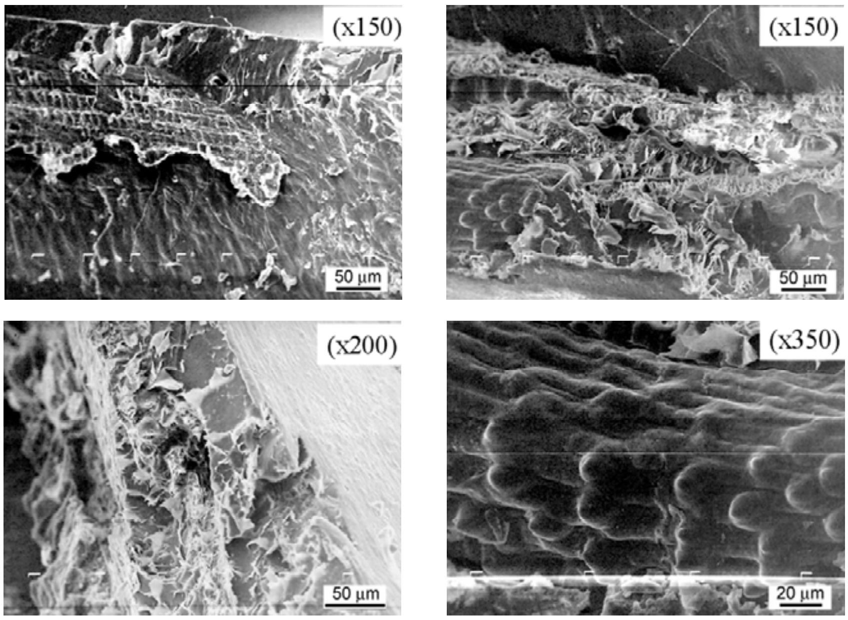


Figure 10. SEM micrographs of PLA/RS/CA (75/20/5 wt%) composites

SEM micrographs of the fractured surfaces of PP/RS/CA (75/20/5) and PLA/RS/CA (75/20/5) composites are shown in figures 9 and 10. Composites show evidences of plastic deformation. The rice straw surface is well covered by the polymer phase, thus indicating an improved level of interfacial adhesion between the rice straw filler and the polymer matrix.

Characteristic TGA thermograms of the studied systems are presented in figures 11 and 12.

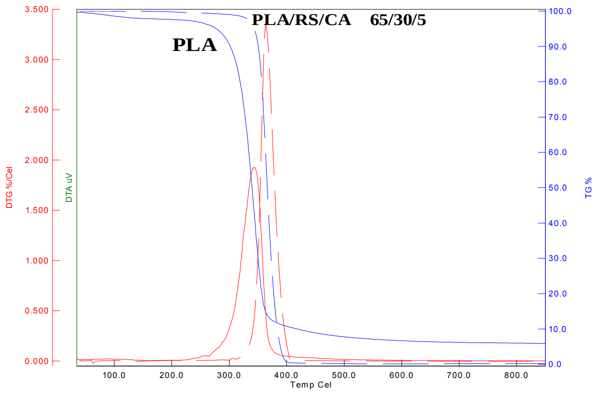


Figure 11. Characteristic thermograms of PLA and PLA/RS/CA (65/30/5 wt%) composite

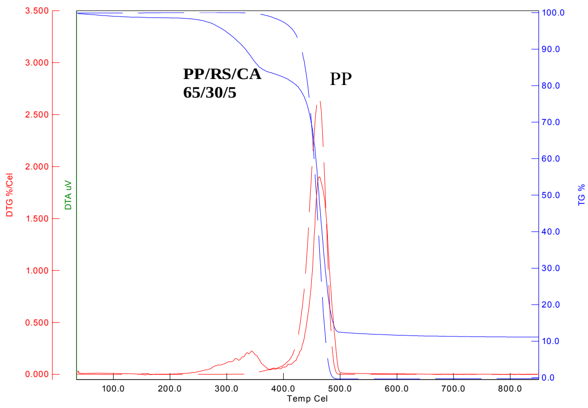


Figure 12. Characteristic thermograms of PP and PP/RS/CA (65/30/5 wt%) composite

Thermogravimetric curves of rice straw/polypropylene composites exhibit two main weight loss steps, the first one attributed to rice straw and the second one to the polymer matrix, while TGA curves of PLA/RS composites exhibit one step decomposition.
The weight loss step of the polypropylene matrix is slowly up to 430°C, then the decomposition process occurs rapidly and is completed at 560°C. The thermogravimetric curve of rice straw exhibits two weight loss steps: the first one, below 100°C, results from the evaporation of absorbed moisture, while the second step, occurring in the range 170-550°C, is due to the decomposition of the three major constituents of rice straw (cellulose, hemicellulose and lignin). Lignocellulosic materials are chemically active and decompose thermochemically between 150 and 500°C: hemicellulose, mainly between 150 and 350°C, cellulose between 275 and 350°C, and lignin between 250 and 500°C. Ash in the rice straw (12 wt%) is mainly composed of silica (~ 96 wt%); the amount and the distribution of silica in the rice straw is likely to be an important factor in determining the properties of the composites.

Deviations and corrective actions

WP1 has been extended up to the 18th month, in order to obtain more detailed results related to the task 1.3 (tailoring of the fiber/matrix interaction and interface characterization in green eco-composites). No corrective actions are foreseen for this deviation.

Deliverables

D1 Natural fibre composite samples at lab scale
Delivery date: 12TH month; actual delivery date: 12TH month.

Milestones

Thermoplastic biocomposites at lab scale for properties assessment

The milestone of this WP has been achieved in the due time.

WP2: Design and processing of panellised natural fibre composite structural components and suitable means for their connecting

Lead contractor: Partner n 2 – CIDEMCO

Workpackage objectives

a) Design and processing of panellised natural fibre composite structural components
b) Development of suitable means for connecting with an emphasis on ease of assembly and modification during the life of the building

The tasks planned for WP2 were briefly reported as follows:

T2.1 Design of panellised natural fibre composite structural components

T2.2 Processing of panellised natural fibre composite structural components

Progress towards objectives

Due to the importance of WP2 for the successful realization of the project tasks, all project partners were involved in this work package.

T2.1: Design of panellised natural fibre composite structural components

According to the technical Annex, the partners 1, 2, 6, 7 and 12, involved in this task, have worked with the aim to design panellised natural fibre composite structural components. Special attention was focused on the preparation of composite preforms with homogeneous distribution of the fibres and improved fibre-matrix adhesion. On the bases of the previous work carried out with natural fibres and selected polymer matrices, optimal conditions for design of panellised natural fibre composite structural components have been suggested for the further work. In the tables 12 and 13 and in figure 13, characteristics of some of the tested NFC preforms (consisting of kenaf fibres and PP and PLA matrices) are shown.

Table 12. Main characteristics of some of the tested kenaf/PP preforms

Composition	Size, mm	Thickness, mm	Specific weight, kg/m^3
50% kenaf, 35% polyester, 15% bicom	300 x 300	8 - 10	40
70% kenaf, 30% polypropylene	300 x 400	8 - 10	60
50% kenaf, 50% polypropylene	300 x 400	25	80
70% kenaf, 30% polypropylene	300 x 400	40	40
80% kenaf, 20% bicom	300 x 400	40	40
80% kenaf, 20% bicom	300 x 400	50	50
80% kenaf, 20% bicom	300 x 400	50	45
80% kenaf, 20% bicom	1200x10000	10 - 12	60

(bicom: polyester based bi-component fibres)

Figure 13. Kenaf/PP preforms (semi-products)

Table 13. Main characteristics of some of the tested kenaf/PLA preforms

Composition	Size, mm	Thickness, mm	Specific weight, kg/m^3
70% kenaf / 30% PLA	400 x 600	60	40
70% kenaf / 30% PLA	400 x 600	50	40
70% kenaf / 30% PLA	400 x 600	40	60
70% kenaf / 30% PLA	400 x 600	40	80
70% kenaf / 30% PLA	400 x 600	40	40
70% kenaf / 30% PLA	400 x 600	30	40
70% kenaf / 30% PLA	120 x 120	30	80
70% kenaf / 30% PLA	400 x 600	10	60
60% kenaf / 40% PLA	400 x 600	20	60

Partner 6 has worked to complete design of natural fibre composites based on kenaf and PLA matrix. Physical and mechanical characteristics of the analysed PLA/kenaf composites are presented in table 14, as well as in figures 14, 15 and 16.

Table 14. Physical and mechanical characteristics of PLA/kenaf composites 40/60 wt/wt

Property	Test Method	Composite: PLA/kenaf (d=60 mm; r=40 kg/m3)	Composite: PLA/kenaf (d=50 mm; r=40 kg/m3)	Composite: PLA/kenaf (d=40 mm; r=60 kg/m3)
Area weight, kg/m^2	JUS G.S2.51	6.8	4.5	6.1
Water absorption, %	ISO/DP 9674	64.6	180.0	85.1
Fire resistance	UL 94	burns	burns	burns
Flexural strength, MPa	DIN 53457	11.8	1.76	10.0
Flexural modulus, GPa	DIN 53457	1.1	0.08	0.6
Impact strength, kJ/m^2	DIN 53453	53.8	9.5	60.0
Impact strength, kJ/m^2	DIN 53453	93.7	12.1	84.0
Compression strength, MPa	DIN 53454	3.6	0.87	3.5

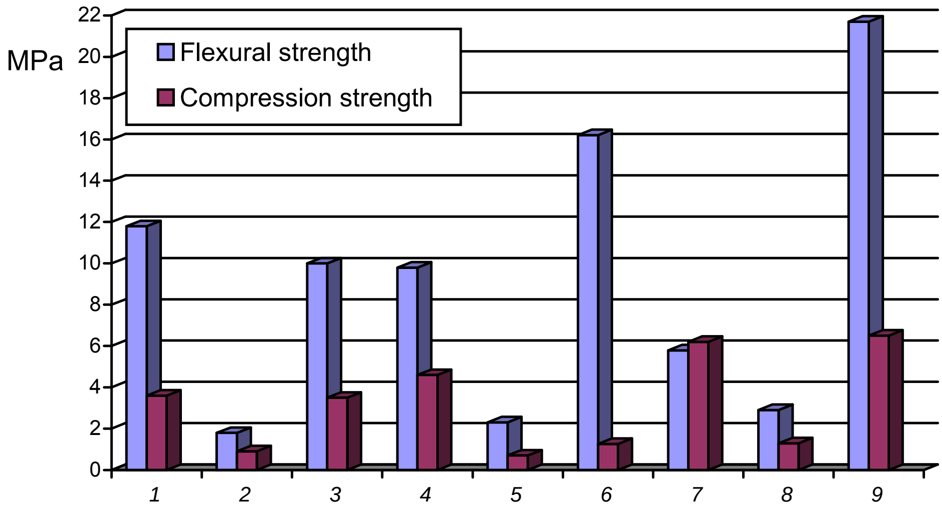


Figure 14. Flexural and compression strength for PLA/kenaf composites 40/60 wt/wt

1 – d=60mm; r=40kg/m3; 2 – d=50mm; r=40kg/m3;
3 – d=40mm; r=60kg/m3; 4 – d=40mm; r=80kg/m3;
5 – d=40mm; r=40kg/m3; 6 – d=30mm; r=40kg/m3;
7 – d=30mm; r=80kg/m3; 8 – d=10mm; r=60kg/m3;
9 – d=20mm; r=60kg/m3.

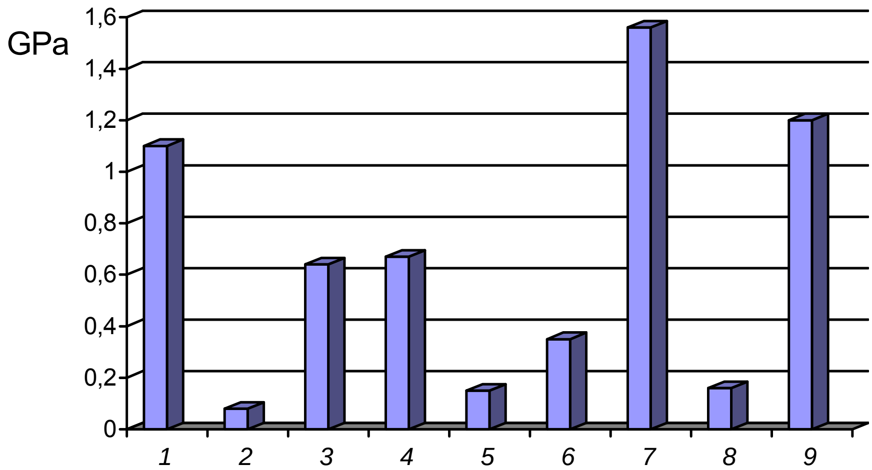


Figure 15. Flexural modulus for PLA/kenaf composites 40/60 wt/wt

1 – d=60mm; r=40kg/m3; 2 – d=50mm; r=40kg/m3;
3 – d=40mm; r=60kg/m3; 4 – d=40mm; r=80kg/m3;
5 – d=40mm; r=40kg/m3; 6 – d=30mm; r=40kg/m3;
7 – d=30mm; r=80kg/m3; 8 – d=10mm; r=60kg/m3;
9 – d=20mm; r=60kg/m3.

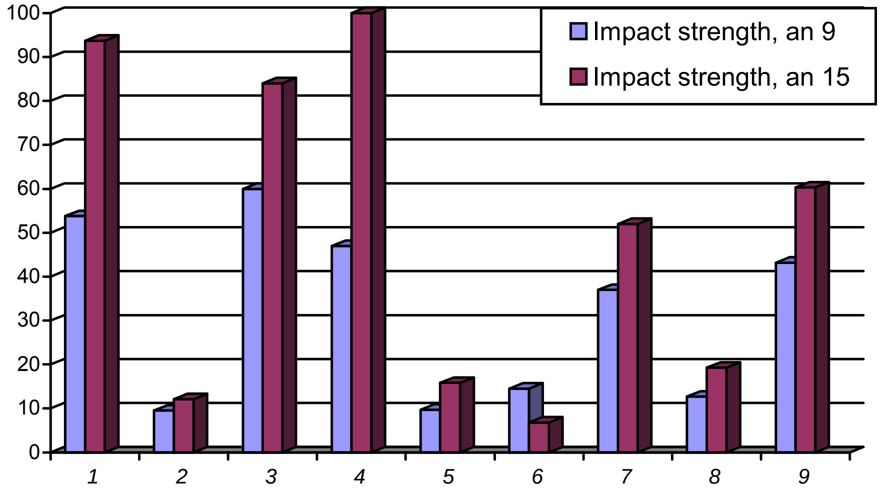


Figure 16. Impact strength for PLA/kenaf composites 40/60 wt/wt
1 – d=60mm; r=40kg/m3; 2 – d=50mm; r=40kg/m3;
3 – d=40mm; r=60kg/m3; 4 – d=40mm; r=80kg/m3;
5 – d=40mm; r=40kg/m3; 6 – d=30mm; r=40kg/m3;
7 – d=30mm; r=80kg/m3; 8 – d=10mm; r=60kg/m3;
9 – d=20mm; r=60kg/m3.

Partner 2 has studied the effects of the compatibilized PLA and PHBV matrix in eco-composites. The effect of compatibilized PLA and PHBV matrix in PLA/kenaf and PHBV/kenaf composites has been evaluated by fire resistance (figure 17) and mechanical tests. It was found that :

- PLA composites show better fire-resistance results
- Neat polymers: they looses integrity very quickly
- Composites with high PLA contents show dropping of burning material
- PLA: higher fiber amount does not change fire resistance behaviour
- PLA: compatibilization does not change fire resistance behaviour
- PHBV: higher fiber amount increases fire resistance
- PHBV: compatibilization increases fire resistance

The results of the mechanical properties showed that compatibilization improves Young's modulus (max improvement 150%).

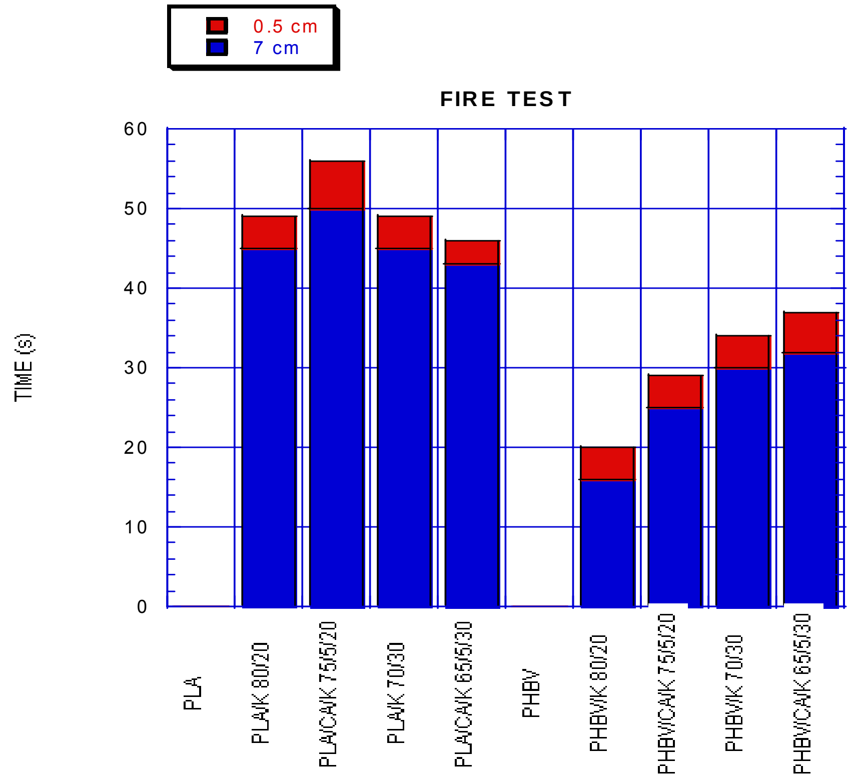


Figure 17. Results of fire resistance tests on PLA/K/CA and PHBV/K/CA composites

Namely for PLA/CA/K 65/5/30 an improvement of 400% was recorded with respect to neat PLA. For PHBV/CA/K 65/5/30, an improvement of 59% with respect to neat PHBV was found. Moreover, compatibilization does not improve much tensile strength (max improvement of 130% in PLA/CA/K 65/5/30 wt%).

T2.2 Processing of panellised natural fibre composite structural components

Partner 6 worked on processing of PLA/kenaf composites. The application of the same press cycle (open mold and high pressure), already used for PP/kenaf composites was impossible because PLA was squeezed out of the fibers.

In order to solve the problem of PLA squeeze out, a closed mold and 9.0 mm thick spacers were applied, in order to prevent full closure of the mold and migration of PLA to the boundaries of the composite panel. All manufactured composites of PLA/kenaf were 120x120x~9.0 mm.

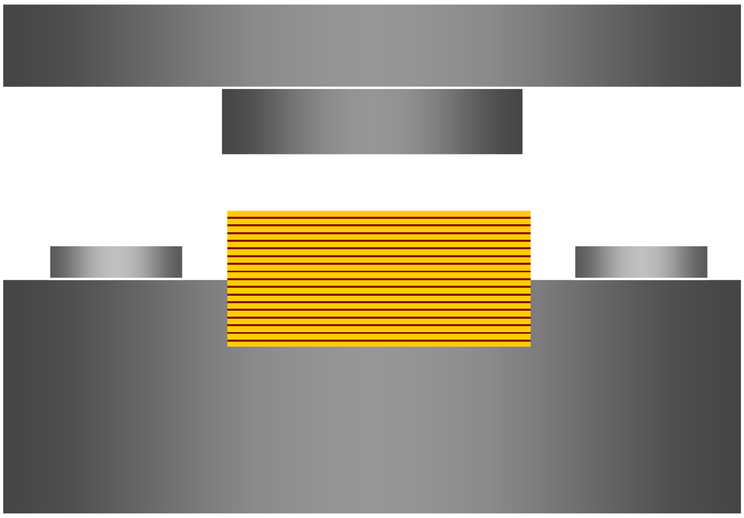


Figure 18. Mold in open position

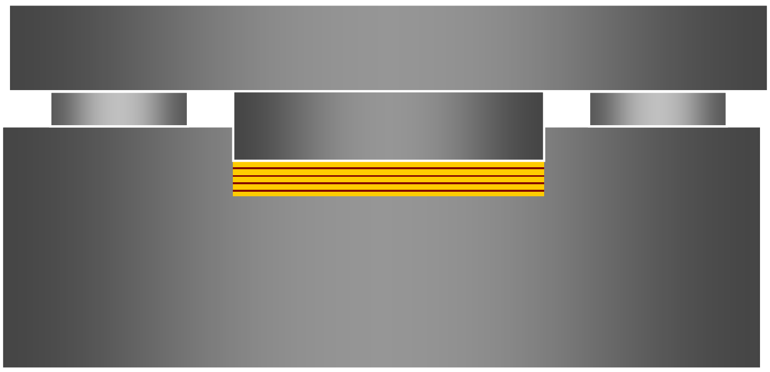


Figure 19. Mold in closed position

With this technological procedure, composites from all available PLA/kenaf preforms were realized, using 2 or 4 layers of kenaf/PLA panels in dependence of the thickness of the starting kenaf/PLA preforms (to get composite samples with thickness approximately 9 mm). After the optimization procedure, the best results were obtained at the following processing conditions: T = 175°C, closed mold, t = 20 min. Main properties of the composites produced in these conditions were analyzed.

TGA characterization of NF

The manufacture of polymer composites requires the mixing of natural fibers with polymer matrix at temperatures above the melting temperature of the polymer. A prolonged exposure of the fibers at such high temperatures raises the question about the thermal stability of the fiber. TGA curves of raw and differently treated kenaf fibers are shown in Figure 18, and the obtained decomposition temperatures (T_d) are listed in table 11. All investigated fibers showed two-stage decomposition curves and an onset of degradation between 190 and 230°C. However, rapid weight loss is observed for acetylated fibers at temperature well below 200°C.

Table 15. Decomposition temperature at different weight loss of treated kenaf fibers

Differently treated kenaf fibers	T_d [°C] 3 %	T_d [°C] 45 %	T_d [°C] 85 %
Untreated	326	384	415
Acetylated	163	412	460
Alkali treated	284	360	416
ACN grafted	294	358	393

Using the Flynn and Wall expression, an attempt was made to calculate the activation energy of thermal decomposition. As can be seen from table 15, the activation energy (*Ea*) for thermal decomposition increased for alkali treated kenaf fibers, which correlates with the results of WAX analysis.

DTG curves of differently treated kenaf fibers (figure 19) exhibit two peaks: first one at ~ 220°C for acetylated fibers and at ~ 350°C for the raw, alkali and ACN treated fibers which is mainly due to hemicelluloses decomposition. The second peak, attributed to cellulose and lignin decomposition is around 430°C and is slightly higher for all treated kenaf fibers (see table 15).

Table 16. Activation energy of thermal decomposition for 10% and 40% of weight loss

Fiber	E_a [kJ/mol] 10 % w.l.	E_a [kJ/mol] 40 % w.l.
Kenaf (raw fiber)	48.9	244.7
Kenaf (acetylated)	376.5	143.9
Kenaf (alkali treated)	445.0	562.6

Table 17. DTG data for $T_{max\ 1}$ and $T_{max\ 2}$ (V_h=20 K/min)

Fiber	$T_{max\ 1}$ [°C]	$T_{max\ 2}$ [°C]
Kenaf (raw fiber)	360	420
Kenaf (acetylated)	205	433
Kenaf (alkali treated)	350	435
Kenaf (ACN-grafted)	365	430

The other studies related to the surface treatment of natural fibers has shown unchanged, slightly decreased or increased thermal stability. Natural fiber stability was directly related to the type of the reagent used for the surface treatment. Namely, esterification of the lignocellulosic materials with maleic and succinic anhydride led to decreased thermal stability, while the treatment with fatty acids, acrylonitrile and methyl methacrylate had an opposite effect.

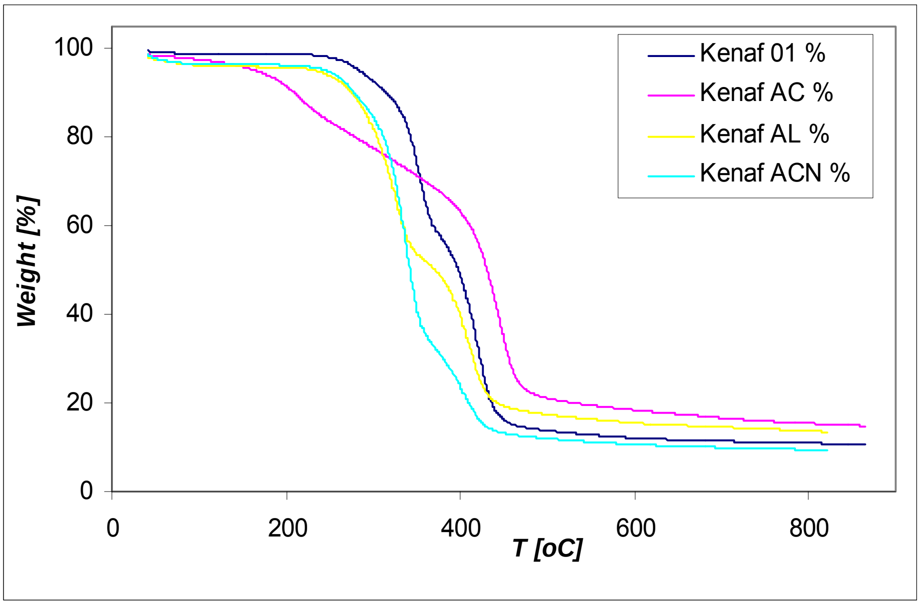


Figure 20. TGA curves of differently treated kenaf fibers

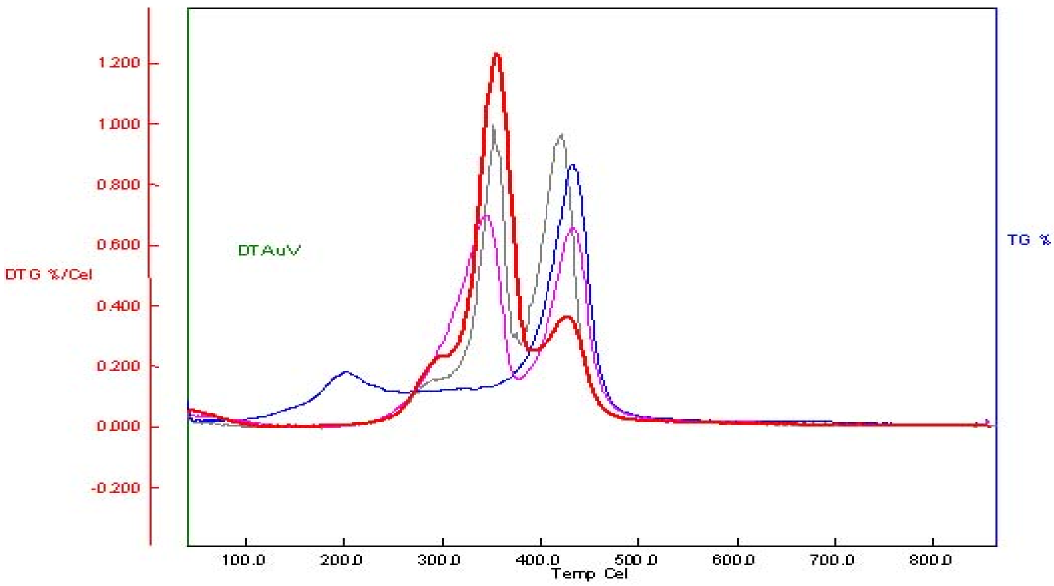


Figure 21. DTG curves of treated kenaf fibers
(grey-Kenaf , blue-Kenaf-AC, red-Kenaf ACN, pink-Kenaf AL)

Deviations and corrective actions

No significant deviations have to be remarked for this WP.

Deliverables

D2 Report on the optimum conditions in order to design natural fibre composites
Delivery date: 18TH month.

D3 Report on the optimum conditions in order to process natural fibre composites
Delivery date: 18TH month.

Deliverables D2 and D3 were delivered on time: 18th month.

Milestones

Production of demonstrators with the optimised materials composition to achieve targets to be tested on WP3 and WP4

The only milestone of this WP has been achieved in the due time.

WP3: Development of panellised components with integral thermal and acoustic insulation for improvement of energy efficiency in eco-buildings

Lead contractor: Partner n 11 – GEONARDO

Workpackage objective

a) Development of panellised components with integral thermal and acoustic insulation for improvement of energy efficiency in eco-buildings

The tasks planned for WP3 are reported as follows:

T3.1 Achievement of panels with high thermal and acoustic properties

T3.2 Development of methods for the assessment and the optimisation of housing comfort

Progress towards objectives

T3.1 Achievement of panels with high thermal and acoustic properties

Unless from the timetable of the project the starting of the task 3.1 activities was planned at the 19th month, some preliminary activities of this task have been performed in the 3rd semester of the project. In particular, new panels with high thermal and acoustic properties realized with biodegradable materials have been prepared by Kefi (Partner 4). As natural fiber component, kenaf fibers have been used, whereas PLA fibers have been selected as gluing component in these panels.

After preliminary studies reported with detail in the periodic activity reports, the following panels have been selected and realised at semi-industrial scale by the Partners 2 (Cidemco), 3 (Mondirect), 4 (Kefi) and 6 (Eurokompozit-Kompositna Oprema) according to the task 3.1. These panels have been prepared also through the activities performed in the frame of task T4.1 (Development of appropriate manufacturing technique suitable for rapid industrial application).

Panel ECO-PCCM-1: PLA/CA/Kenaf with fire retardant and pigments

Panel ECO-PCCM-2: PLA/CA/Rice straw with fire retardant and pigments

Panel ECO-PCCM-3: PLA/kenaf

The first two panels, characterized by relatively higher density, can be used to be used as interior panels in eco-houses. The third kind of panels, characterized by low density, can be used as insulation materials in eco-houses.

In the following tables and figures the main technical characteristics of these panels are reported together with some images of them.

Table 18: Results of the characterization of panel ECO-PCCM-1

Composition		
PLA	65.8 %	Partner 2
Maleated PLA	4.4 %	Partner 2
Kenaf fibers	17.5 %	Partner 2
Pigment (iron oxide)	3.5 %	Partner 2
Fire retardant (aluminium oxide)	8.8 %	Partner 2
Thickness/volume mass		
Thickness	9.8 mm	Partner 8
Volume mass	896 kg/m^3	Partner 8
Tensile properties		
Modulus, E	5600 MPa	Partner 2
Stress at break, σ	56 MPa	Partner 2
Strain at break, ε	1.6 %	Partner 2
Flexural properties		
Modulus, E	5580 MPa	Partner 2
Stress at break, σ	88 MPa	Partner 2
Strain at break, ε	2.3 %	Partner 2
Thermal properties		
Vicat Softening Temperature	64 °C	Partner 2
Degradation temperature (N_2)	325°C (onset)	Partner 1
Burning	Burns with yellow flame	Partner 8
Ash content	4.8 %	Partner 8
Thermal insulation		
Thermal conductivity	$\lambda_{10°C} = 0.169\ W\ m^{-1}\ K^{-1}$	Partner 8
Water absorption		
Water absorption (immersion)	9.3 %	Partner 8

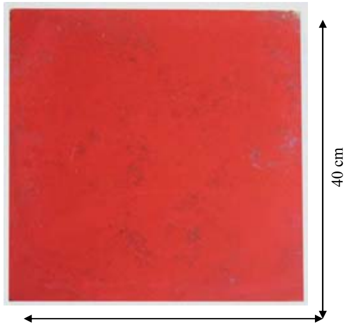


Figure 22: Image of the of panel ECO-PCCM-1

Table 19: Results of the characterization of panel ECO-PCCM-2

Composition		
PLA	65.8 %	Partner 2
Maleated PLA	4.4 %	Partner 2
Rice straw	17.5 %	Partner 2
Pigment (iron oxide)	3.5 %	Partner 2
Fire retardant (aluminium oxide)	8.8 %	Partner 2
Thickness/volume mass		
Thickness	10.0 mm	Partner 8
Volume mass	1221 kg/m^3	Partner 8
Tensile properties		
Modulus, E	5200 MPa	Partner 2
Stress at break, σ	43 MPa	Partner 2
Strain at break, ε	1.2 %	Partner 2
Flexural properties		
Modulus, E	4060 MPa	Partner 2
Stress at break, σ	77 MPa	Partner 2
Strain at break, ε	2.8 %	Partner 2
Thermal properties		
Vicat Softening Temperature	66 °C	Partner 1
Degradation temperature (N_2)	334°C (onset)	Partner 1
Burning	With yellow flame, self-estinguishing	Partner 8
Ash content	5.8 %	Partner 8
Thermal insulation		
Thermal conductivity	$\lambda_{10°C} = 0.179\ W\ m^{-1}\ K^{-1}$	Partner 8
Water absorption		
Water absorption (immersion)	2.8 %	Partner 8

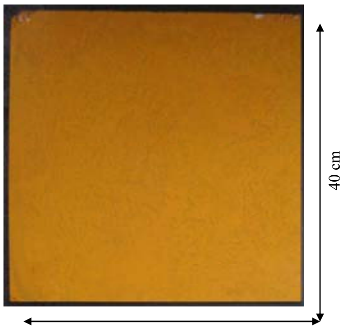


Figure 23: Image of the of panel ECO-PCCM-2

Table 20: Results of the characterization of panel ECO-PCCM-3

Composition		
PLA	40 %	Partner 4
Kenaf fibers	60 %	Partner 4
Thickness/volume mass		
Thickness	20 - 80 mm	Partner 4
Volume mass	20 - 40 kg/m^3	Partner 4
Thermal properties		
Degradation temperature (N_2)	310°C (onset)	Partner 1
Burning	With yellow flame	Partner 8
Ash content	8.5 %	Partner 1
Thermal insulation		
Thermal conductivity	$\lambda_{10°C}$ = 0.039 - 0.034 W m^{-1} K^{-1}	Partner 4
Acoustic insulation		
Please refer to Deliverable D4		Partner 4

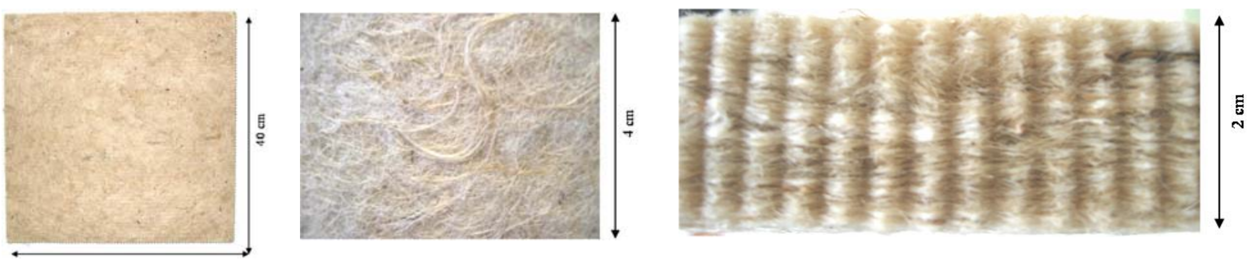


Figure 24: Images of the of panel ECO-PCCM-3

Details about the properties of the above described panels are reported in the Deliverable D4. Acoustic properties of the others ECO-PCCM composites were analysed in the 5th semester of the project by the partner no.8-USKIM-ZIMRANT. The obtained data have been compared with the data measured for the similar construction materials such as Kenaf panels, Plaster carton panels, etc.

Acoustic protection

Table 21: Level of standardized sound from blow O NORM B 81154

Mass (kg/m^2)	Massive ceiling Lmw, eq = 164-35 lym (db)	massive ceiling with lowered ceiling and mineral wool d =50mm (db)
190	84	84
270	79	79
380	74	71
530	69	67

a) Acoustic insulation RW (for lowered ceiling) according to EN 12354 - 1

Mass (kg/m^2)	Massive ceiling Rw (db) Rw = 32-36	Massive ceiling with lowered ceiling and mineral wool d =50mm (db)	
		frequency 80 Hz	frequency 100 Hz
190	48	11	8
270	53	8	5
380	57	6	3
530	62	4	1

Kenaf ECO-PCCM material

Table 22: Main properties of Kenaf ECO-PCCM materials

(mm)	kg/m^3	$K_\beta w$	$W(m^2k)$	$100\text{-}4000Hz(10^0\text{-}30^0C)$
20	20	3.3	0.39	64 dB
50	20	3.1	0.040	65 dB
100	20	3.6	0.041	67dB

(mm)	kg/m^3	KPa	%	Stability on temperature
20	30	5.3	19	$-25^0C(-0.22\%)$ $+75^0C(+0.56\%)$

Technical Conditions for design of Residential Structures MKS U.J5.600

The standard anticipates construction in compliance with:

- climatic construction zones
- prescribed minimal thermal isolation of engineering structures
- requirements regarding the vapor diffusion through the engineering structure
- defined loss of heat depending on the openings and their frames.

Sound absorption

The results of the acoustic measurements are reported in the following tables.

The absorption coefficient was evaluated in “KUNT” tube, according to MKS U.J6.224 (with measuring tube 10 cm and 3 cm).

The testing was carried out on tubes with thickness of d=1,0 cm

Table 23: PLA/CA/KENAF panels – Results of sound absorption measurements

No.	f [Hz]	Absorption coefficient α [%]	Volume mass [kg/m3]
1	167	7.5	1291
2	209	9.0	
3	250	7.0	
4	333	10.0	
5	416	9.0	
6	500	5.0	
7	660	7.5	
8	733	6.0	
9	1000	10.0	
10	1333	9.5	
11	1666	9.5	
12	2000	12.5	
13	2666	13.0	
14	3332	14.0	
15	4000	17.9	

Table 24: PLA/CA/RICE STRAW panels – Results of sound absorption measurements

No.	f{Hz)	Absorption coefficient α (%)	Volume mass (kg/m^3)
1	167	7,5	1272
2	209	8,0	
3	250	7,7	
4	333	11,0	
5	416	9,0	
6	500	5,0	
7	660	7,5	
8	733	6,0	
9	1000 (1KHz)	10,0	
10	1333	9,0	
11	1666	9,0	
12	2000 (2KHz)	12,0	
13	2666	13,0	
14	3332	14,0	
15	4000	17,0	

Table 25: Comparison of ECO-PCCM material with other construction materials according to standard criteria

Material	kg/m^3	Thermal conductivity coefficient λ = w/ mK
Filled brick	1200-1800	0.47-0.76
Porous brick	1200-1400	0.52-0.61
Concrete-gas blocks	600-800	0.27-0.35
Filled blocks/light concrete	1000-1600	0.80-0.47
Lime mortar	1800-1900	0.99-0.81
Cement-mortar	2200-2100	1.4
Thermo-insulation materials	1200-600	0.58-0.18
Ceramic	400	0.22
Gravel	1700	0.81
Concrete	1800-2500	0.93-2.33
Ceramic concrete	800-1400	0.29-0.58
Gypsum card table	900	0.23-0.21
Porous gypsum tables	600-800	0.29-0.35
Polyester tables	1500-1400	0.23-0.19
Acrylic glue (pitch)	1180	0.19
Acrylic bricks	40-30	0.035

T3.2 Development of methods for the assessment and the optimisation of housing comfort

A report on methods for the assessment and the optimisation of housing comfort: natural light availability, indoor quality, ventilation, odour nuisances has been prepared with the contribution of Geonardo (Partner 11) and Studio R (Partners 9). The general strategy to realize sustainable construction and buildings with improved quality of life in eco-houses has been pointed out. Moreover, an example of possible construction with an application of ECO-PCCM material in combination with other construction materials has been studied and the related planning is reported in the Deliverable D5. In particular, a system to realize dry buildings has been proposed, as well as the possibilities of assembling the ECO-PCCM materials with traditional materials. Moreover, an application of construction elements in constructing or reconstructing buildings or interiors has been also reported in the Deliverable D5.

Deviations and corrective actions

Amendments to Deliverable D5 have been provided. No further corrective actions are needed for this deviation.

Deliverables

D4 Panels with high thermal and acoustic insulation performances for housing

Delivery date: 24TH month; foreseen delivery date: 24TH month.

D5 Report on methods for the assessment and the optimisation of housing comfort

Delivery date: 24TH month; foreseen delivery date: 24TH month.

Deliverable D4 has been delivered at the 30th month

Deliverable D5 has been delivered at the 24th month (amendments needed) and delivered again at the 30th month.

Milestones

Panellised components with integral thermal and acoustic insulation obtained in eco-materials

The only milestone of this WP has been achieved in the due time.

WP4: Development of appropriate manufacturing technique suitable for rapid industrial application, a wide range of products and optimized low-production costs

Lead contractor: Partner n 6 – EUROKOMPOZIT

Workpackage objective

a) Development of appropriate manufacturing technique suitable for rapid industrial application, a wide range of products and optimised low-production costs

The only task planned for WP4 is reported as follows:

T4.1 Development of appropriate manufacturing technique suitable for rapid industrial application

Progress towards objectives

The processing of polymer rich biocomposites panelized components was performed in three steps:

- Firstly, the fibers, the polymer, the coupling agent and the additives were compounded in a mixer at room temperature
- Then, the blend was extruded and then were pelletized
- The pellets were compression moulded in order to obtain the panels

Firstly, in order to obtain an accurate mixing level between the fibres and the polymer, the components must be physically blended in a mixer. A lab scale mixer was employed as that shown in figure 5. This mixer operates on friction conditions. It is composed of a vessel equipped with shaped mixing tools with a controlled speed and temperature. The labo-mixer allows a three dimensional product movement with intense friction and heat to give rise a uniform product in the shortest time.

Figure 25. mixer for physical blending of the components

In the next step, this blend was feed into the extruder in order to obtain the extrudates with high mixing level between the components. The extruder should be a corrotating double screw extruder to assure a high quality mixing level. The extruder employed had screws with a diameter of 19 mm and the conditions were the following:

- Screw speed of 250 rpm
- Temperature profile of 170-175ºC

Figure 26 shows a detail of the screws in the extruder that was used.

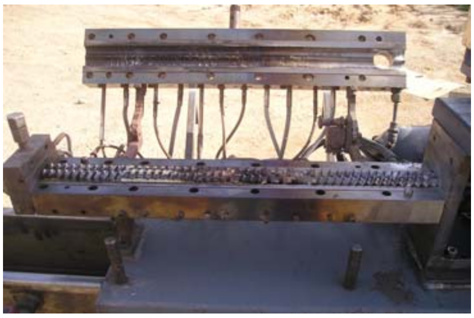
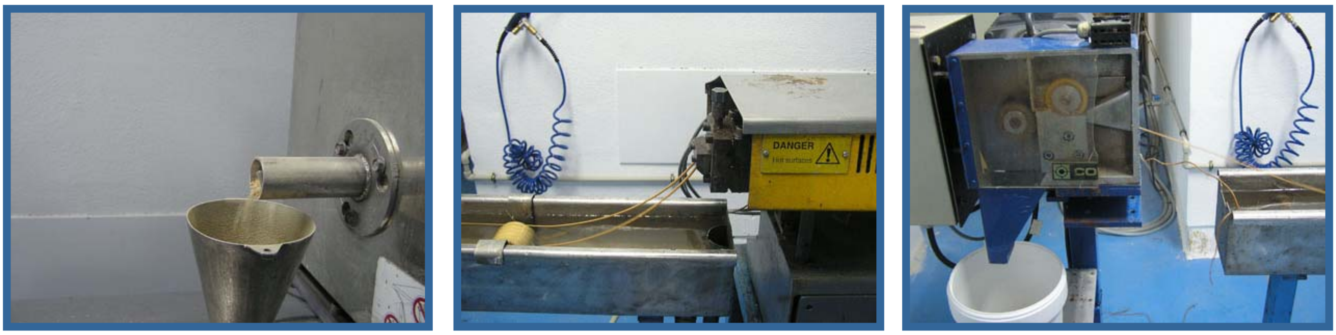


Figure 26. Screws of the extruder

At the exit of the nozzle, the extrudates were cooled with water and chopped as shown in figure 27. Figure 8 shows the blades used in the chopper for the pelletizing process.



Feeding Cooling Pelletizing

Figure 27. Scheme of extrusion process

Figure 28. Chopper

Thus, the compounding process of NFC is a low cost process since usual plastic equipment can be employed. Following the explained process, which is summarized below, accurate pellets for moulding are obtained:

- Physical blending of the components in a mixer
- Compounding or melt-blending of the components in a double screw extruder.
- Cooling and pelletizing

The obtained pellets can be moulded as desired: by extrusion, compression, injection or any processing technique applied to plastics. The composite pannels were obtained by compression moulding. However, in order to determine the properties of the composites, the pellets were injection moulded to obtain test samples as those shown in figure 29.

Figure 29. Flexural and tensile test bars

Among the different matrices selected in the beginning of the project, it was concluded that poly(lactid acid) (PLA) showed the best results, so this polymer was chosen to produce the composites. The fibres employed were kenaf and rice straw and the compatibilizing agent was maleinizated PLA. In order to analyse the obtained composites, flexural and tensile tests were performed according to the standards EN ISO 527 and EN ISO 178, respectively. Figure 30 shows the tensile and flexural moduli of the composites.

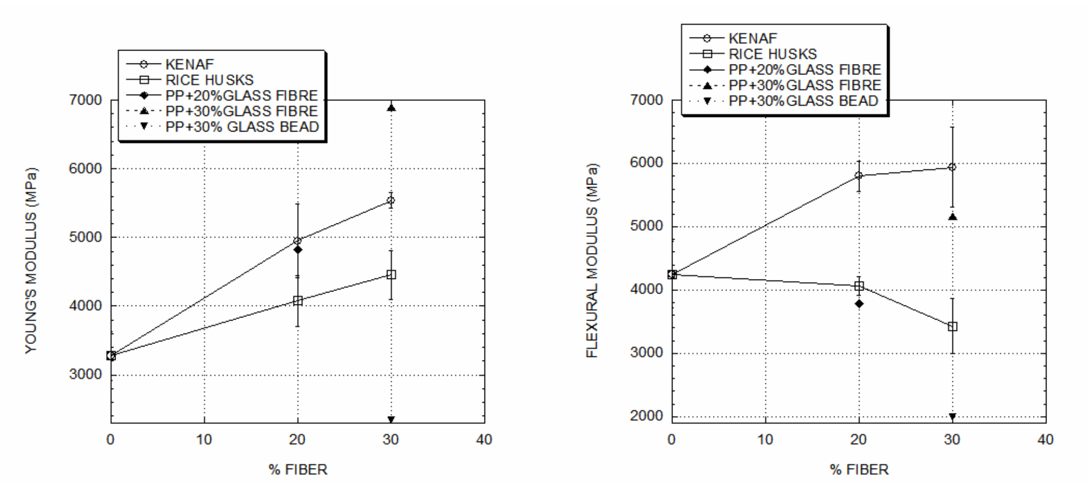


Figure 30. Tensile and flexural moduli of the composites

As can be seen, tensile modulus increased at increasing fibre content, especially with kenaf fibres. Flexural modulus of kenaf composites also increased at increasing fibre content but rice straw composites behave opposite due to the small aspect ratio of these fibers (3.5) compared to that of kenaf (50), which made rice straw fibres act as a filler instead of as a fibre. However, as can also be seen in figure 30, modulus values similar to those of glass fibre filled polypropylene (PP) composites were obtained, and much higher than those of glass beads filled PP composites. Figure 31 shows tensile and flexural strength of the composites. As can be seen, strength decreased in most of the composites, even if kenaf composites showed better mechanical behavior than rice straw composites. These results are a consequence of the increased fragility of the composites after the addition of the fibres, that led to a fracture before reaching the yield point. Values of NF composites are slightly lower than those of 20% glass fibre filled PP composites.

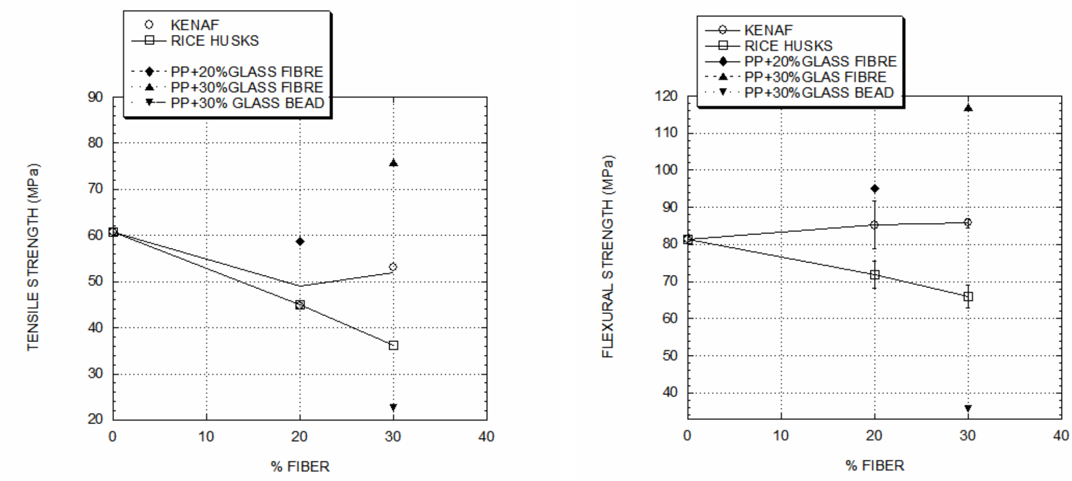


Figure 31. Tensile and flexural strength of the composites

According to the mechanical performance and taking into account that processability of the composites was much easier with 20% of fibre, the composite with 75% PLA, 5% coupling agent and 20% fibre (kenaf or rice straw) was selected as the most suitable composition. However, these composites showed bad durability behavior.

With the aim of improving fire and durability performance, additives were added to the composites. The additives were a fire retardant and a pigment. Among fire retardants aluminium hidroxide ($AlOH_3$) and ammonium polyphosphate were selected for being environmentally friendly materials, while iron oxide was used as a pigment in order to improve the substrate protection against light. The additives contents analysed were the following:

- Fire retardant: 10 and 20%
- Pigment: 2 and 4%

In some preliminary tests it was found that ammonium polyphosphate gave rise to bad durability behavior, so it was discarded.

Fire tests were carried out according to the EN ISO 11925.2 standard (single flame source test). Figure 32 compares the fire test results before and after additives addition for both fibres.

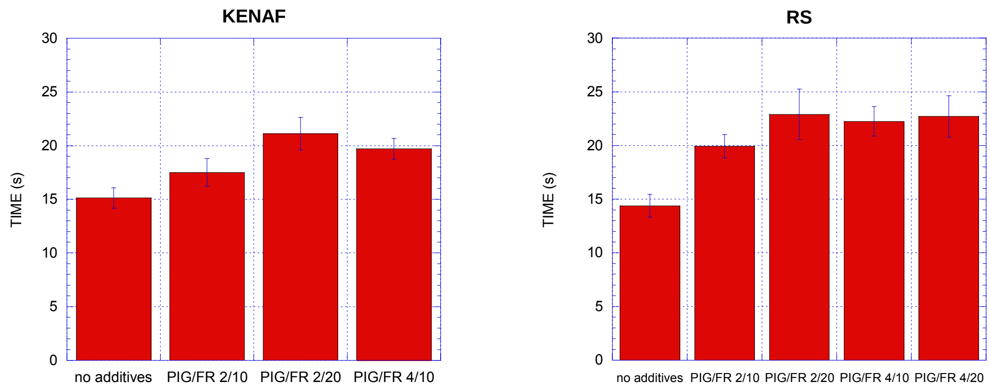


Figure 32. Fire tests results

As can be seen, the addition of fire retardant increased fire performance remarkably, especially at higher additive contents. However, the most environmental composite will have the lowest inorganic content. In order to determine the most suitable additive content, flexural tests were performed. Results indicated that the additives did not change the mechanical performance of the composites, so 4% of pigment and 10% of fire retardant were selected as the most suitable additive contents.

Vicat softening temperature was also determined. Results are shown in table 5. The addition of the fibre did not improve the softening temperature. However, inorganic additives increased softening temperature, what widens the applicability of such composites.

Table 26. Vicat softening temperature

Composition	VST (°C)	
	Kenaf	Rice husks
PLA	58	58
20% fibre	56	57
20% fibre, 4% PIG, 10% FR	64	66

Finally, durability performance was determined in a QUV machine with the following cycle:

- UV-B lamp: 4h at 60ºC
- Condensation of steam water: 4h at 50ºC

In order to determine the durability performance, the aspect and the mechanical property retention after different ageing times were analysed. Figure 13 shows the flexural properties retention for both fibres. As can be seen, the modulus retention is very good, while strength decreases remarkably at an ageing time of 1000h. However, the property retention up to 1000h is very good.

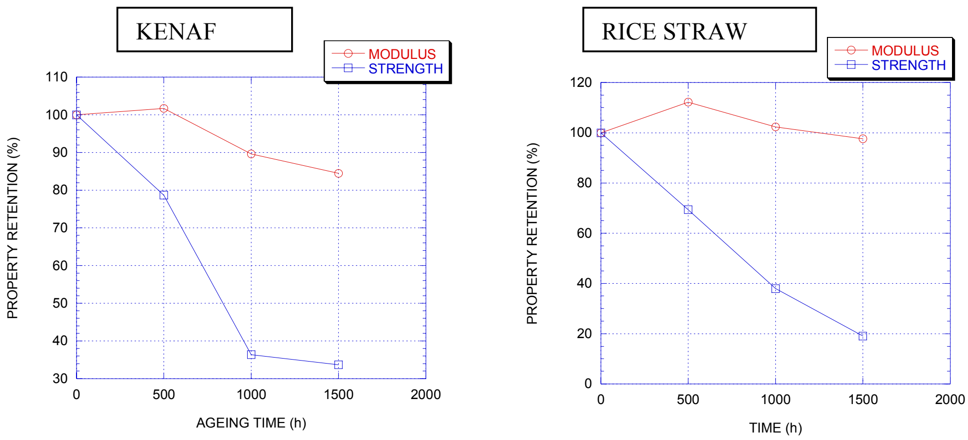


Figure 33. Flexural modulus and strength after ageing

Regarding the aspect of the samples after ageing, figure 34 compares the aspect of the composites after 1000h in the ageing chamber with and without additives. As can be seen, in non-additivated composites bleaching, cracking and chalking takes place after 1000h. After 1500h a complete fracture of the samples was observed. On the contrary, the additivated composites showed much better appearance with no bleaching nor chalking, just some few cracks appeared after 1500h.

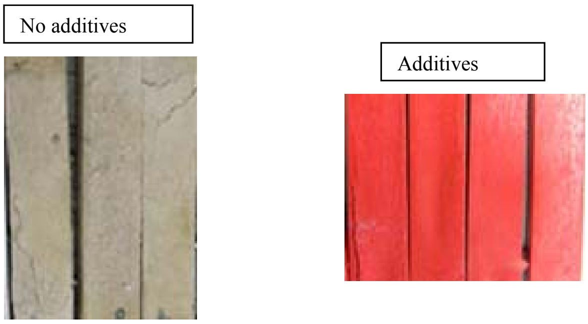


Figure 34. Detail of the composites after ageing

Deviations and corrective actions

Unless the activities of this WP were foreseen to be started at the 24th month of the project, partner n 10, in agreement with the coordinator, has begun a preliminary work related to this WP t the 18th month. No corrective actions were needed for this deviation.

Deliverables

D6 Process to produce biocomposites panellised components

Delivery date: 36TH month; foreseen delivery date: 36TH month.

D7 Report on natural fibre composite products at low-production cost

Delivery date: 36TH month; foreseen delivery date: 36TH month.

Deliverables D6 and D7 were delivered on time: 36th month.

Milestones

Production of appropriate manufacturing technique suitable for the industrial production of wide range of products in biocomposites and optimised low-production costs

The only milestone of this WP has been achieved in the due time.

WP5: Waste minimization – Reuse and Recycling

Lead contractor: Partner n 5 – TMF

Work-package objectives

a) Development and design of recycling-reuse facilities for transformation/conversion of solid-plastic waste (not only from construction activities) into polymer mortars for the low-cost building industry
b) Development of methods-guidelines for the waste minimization after the use of the eco-friendly polymer construction composites in the building/structures
c) Development of materials and process that allow an easy deconstruction-recycling-reuse, selective demolition

The tasks planned for WP5 are briefly reported as follows:

T5.1 Development and design of recycling-reuse facilities

T5.2 Methods-guidelines for the waste minimization

T5.3 Development of materials and process for an easy deconstruction-recycling-reuse, selective demolition of eco-houses

Progress towards objectives

T5.1 Development and design of recycling-reuse facilities

Design of the recycling-reuse facilities of the ECO-PCCM eco-composites is very important from the environmental point of view as well as for the sustainable development of the eco-composite materials. In the frame work of this task, the investigations were divided in three steps:

A) Investigation of the recycling ability of the PP and PLA matrix
B) Application of the recycled matrix for production of the rice straw composites and Kenaf composites
C) Investigation of the recycling ability of the rice straw composites and kenaf Composites

The results obtained for all three steps have been described in detail in the Periodic -II- Year Report.

Here will be presented results obtained for the reuse of recycled ECO-PCCM composites in low-cost polymer mortars.

Preparation and characterization of Polymer Mortars based on recycled ECO-PCCM samples and PES resin

The highest IMPACT of the recycling and reuse of eco-composites is their application as a component into high-quality polymer-mortars (composites) for the low-cost building industry. In the framework of the WP5, polymer mortars based on unsaturated polyester resin and recycled ECO-PCCM composite samples have been designed and analyzed.

Polymer mortars based on:

PES + Recycled ECO-PCCM composites + SAND

were prepared by the following procedure:

- milling
- blending (40/20/40 $^{w}/_{w}$%)
- curing

During the preparation of the polymer mortars, several problems have been faced, such as: cracks of the matrix, bubbles/voids, color un-homogeneity, and different attempts have been done in order to avoid them.

a) PES/RS/SAND

b) PES/RS-PLA/SAND

Fig. 35. Polymer mortars based on recycled ECO-PCCM composites with Rice Straw

a) PES/K/SAND b) PES/K-PLA/SAND

Fig. 36. Polymer mortars based on recycled ECO-PCCM composites with Kenaf Fibers

Besides with ECO-PCCM recycled composites, also an attempt was made to produce polymer mortar with recycled tetrapak material, presented on Fig. 17.

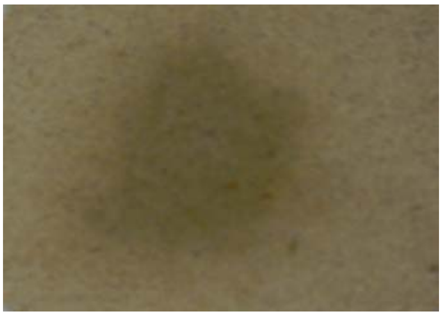


Fig. 37. Polymer mortars based on recycled Tetrapak material

Characterization protocol include mechanical (flexural and impact resistance), DSC and thermo gravimetrical analysis, as well as DMTA. The obtained results are presented on the following tables and figures.

DSC results have shown that *Tg* of the polymer mortars compared to pure PES is shifted to the higher values.

Table 27. DSC analysis of Polymer mortars based on PES
and recycled ECO-PCCM composites

Samples	*Tg* [°C]	Onset	*ΔCp* [J/g°C]	*Tp* [°C]	Onset	*ΔH* [J/g]
DISTITRON 3584	48.1	41.9	0.2			
DST3584 / RS / SAND	52.3	34.1	0.6			
DST3584 / RS-PLA / SAND	46.1	40.5	0.5	131.7	123.7	14.0
DST3584 / KENAF / SAND	55.8	38.2	1.1	253.4	246.8	10.6
DST3584 / K-PLA / SAND	50.3	40.5	0.5	135.3	129.5	11.5
DST3584 / TETRAPAK® / SAND	57.8	38.6	1.3			

The results obtained for the mechanical characterization of the studied polymer mortars are presented in the Tables 28 and 29.

Table 28. Flexural test results for Polymer mortars based on
PES and recycled ECO-PCCM composites

Samples	Flexural tests (un-notched samples)	
	Modulus (MPa)	Stress at maximum load (MPa)
DISTITRON 3584	2710 ± 120	58.4 ± 3.1
DST3584 / RS / SAND	4610 ± 290	23.7 ± 1.6
DST3584 / PLA-RS / SAND	3470 ± 280	17.2 ± 1.3
DST3584 / KENAF / SAND	4190 ± 220	26.6 ± 0.9
DST3584 / PLA-KENAF / SAND	3960 ± 260	21.5 ± 1.5
DST3584 / TETRAPAK® / SAND	3060 ± 220	22.3 ± 0.8

It was noticed that the stress at maximum load decreased for all the studied samples, while the modulus increased for remarkable 40 %.

Table 29. Impact test results for Polymer mortars based on PES and recycled ECO-PCCM composites

Samples	Impact tests (V-notched samples)	
	KC (MN m-3/2)	Resilience (KJ/m2)
DISTITRON 3584	0.59 ± 0.06	0.13 ± 0.03
DST3584 / RS / SAND	1.35 ± 0.14	0.41 ± 0.08
DST3584 / PLA-RS / SAND	0.84 ± 0.07	0.22 ± 0.05
DST3584 / KENAF / SAND	1.48 ± 0.19	0.98 ± 0.11
DST3584 / PLA-KENAF / SAND	0.93 ± 0.04	0.27 ± 0.03
DST3584 / TETRAPAK® / SAND	1.25 ± 0.11	0.86 ± 0.12

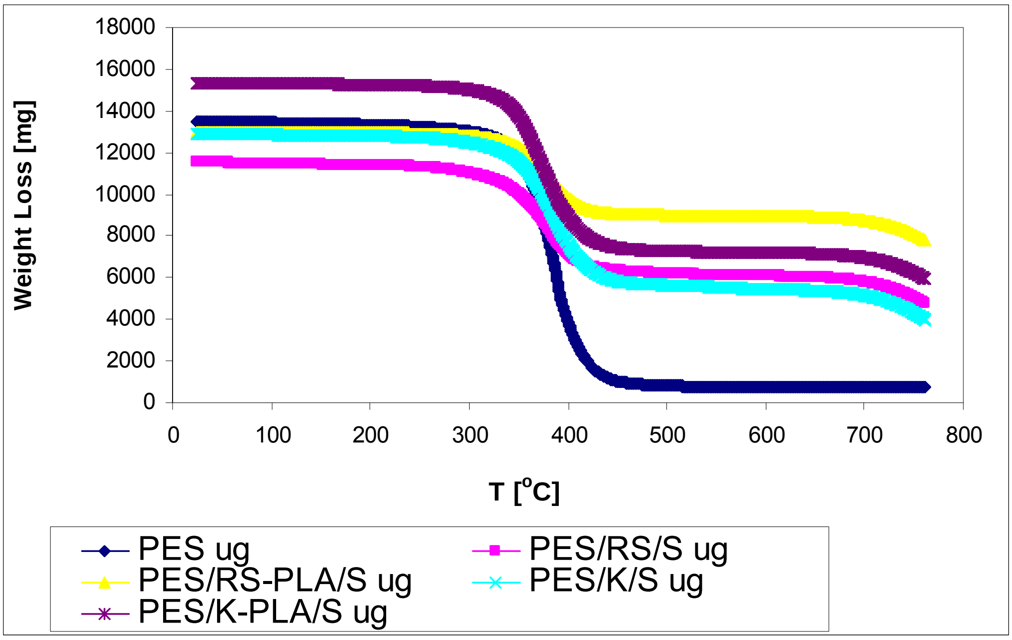


Figure 38. Characteristic TGA curves for ECO-PCCM polymer mortars

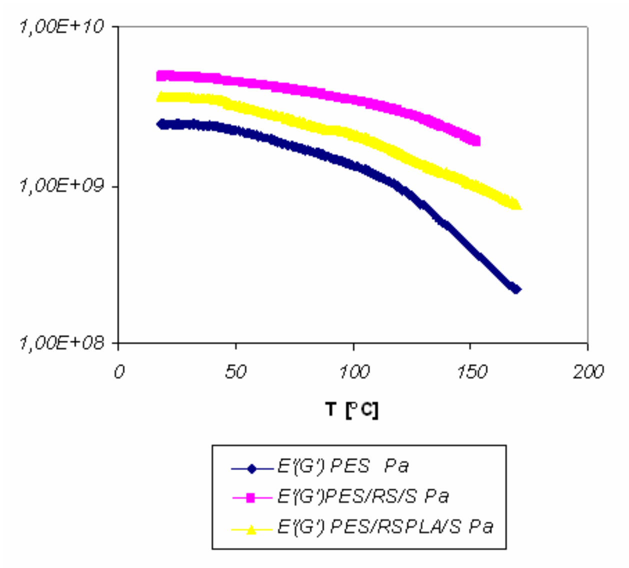


Figure 39: Characteristic DMTA curves for *E'* of the polymer mortars based on ECO-PCCM recycled composites with rice straw

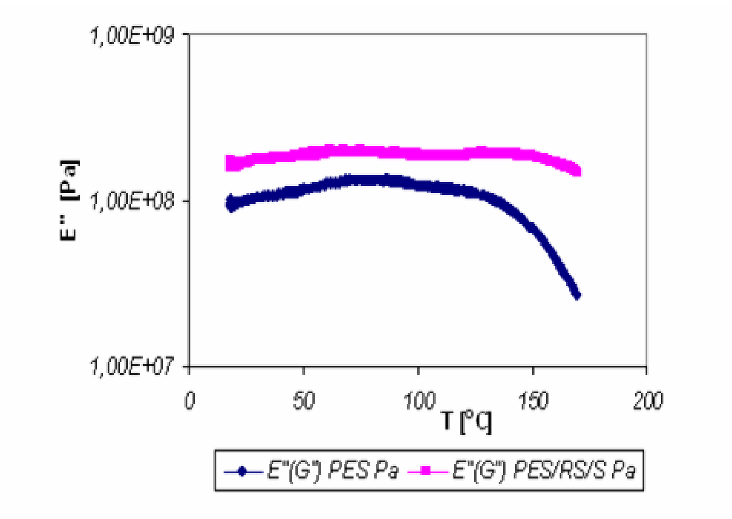


Figure 40: Characteristic DMTA curves for *E"* of the polymer mortars based on ECO-PCCM recycled composites with rice straw

T5.2 Methods-guidelines for the waste minimization

Over the last decade, there has been a strong movement in Europe and the whole world, to develop and design different approaches of construction and industrial waste management towards waste minimization and waste-transformation/conversion. EU directives such as End of Life Vehicles (ELV) and Waste Electrical and Electronic Equipment (WEEE) have put more pressure on solving FRP waste management through recycling and reuse. The ELV directive states that by 2015, 85% of ELVs will have to be reused or recycled (excluding energy recovery), with only 10% incinerated with energy recovery, and only 5% going to landfill1. Whilst this new legislation does not impact on the construction industry, currently in negotiation is the proposed EU recommendation on Construction and Demolition Waste, which if adopted will have a significant effect. FRP suppliers could lose their market share to metal and other industries if they cannot ensure that their FRP components can be reused or recycled at the end of their life.

In the frame work of the project activities in WP5, several methods have been identified and reported for the transformation/conversion of solid-plastic waste used to build eco-house. The most promising are:

- 3R concept,
- Integrated Design Framework,
- LCA and Eco-Indicators,
- Environmental Waste Management,

Successful methods for the transformation/conversion of the solid-plastic waste used to build eco-house should be compatible with the principles of the Sustainable Design and Construction, given bellow:

1. Minimize resource and consumption

- Design for energy efficiency in building design
- Use passive solar and day light
- Select materials and design for durability
- Maximize resource reuse
- Reuse construction materials, assemblies and Products

2. Use renewable or recyclable resources

- Use building material with recycled content
- Specify woods from sustainable forest

3. Protect the Natural Environment

- Minimize disruption of the natural environment in site preparation and construction
- Select materials for low impact in their extraction and processing

3R Concept (*Reduction/Reuse/Recycling*)

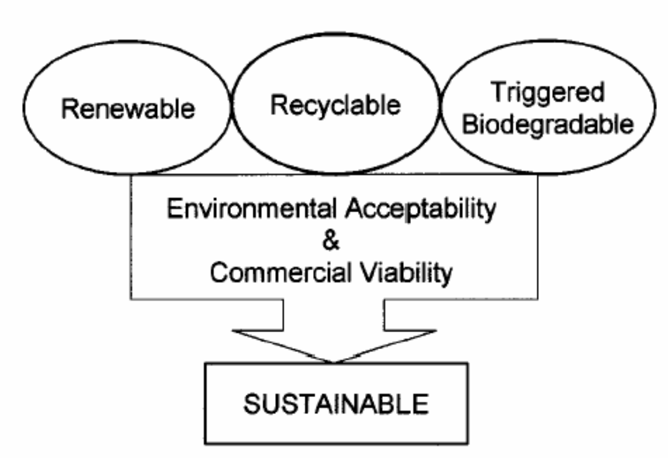


Figure 41: Renewable /Recyclable to Sustainable

The 3R concept is based on the relation *Reduction/Reuse/Recycling*.
Waste source reduction is generally perceived as being the highest rung on the waste minimization ladder with the greatest potential for avoiding energy and raw material consumption as well as waste production. With respect to solid plastic (construction/industrial) waste, source reduction can refer not only to reduction of the volume or weight of waste but also to a reduction of toxicity. Many different approaches have been identified in the literature for reducing construction waste at source. The two main types of source reduction are source control and product changes. A more detailed breakdown of these types of source reduction measures can be found in Table 9.

Waste materials generated during the construction process can be reused or recycled both on-site and off-site. "Reuse" means reusing a waste material directly, either for its original purpose or in a new role, without any major modification to the material before it is reused.

Table 30. Source Reduction Measures

Type of Source Reduction Measure	DESCRIPTION / EXAMPLE
Product Changes	Reduce composite's waste associated with a product's use
- Product Substitution	Substitute degradable/recyclable materials for nondegradable
Source Control	Reduce waste associated with a composite's manufacture
- Input Material Changes	Reduce waste of materials used in the production process
Material Purification	Use a higher grade of crude oil, use nontoxic solvents, water completely recycled in the process
Material Substitution	Substitute renewable source materials for non-renewable ones
- Technology Changes	Reduce waste through process and equipment modifications
Process Changes	Improve efficiency of panel production
Equipment Changes	Use mechanical scraping systems for cleaning
Process Automation	Automatization can optimize product yields by automatically adjusting process parameters
- Good House Construction Practices	Reduce waste by means of procedural and administrative measures

- Reuse is high in the hierarchy, but how practical this might be?

  The use of ground FRP should be beneficial to the product i.e. the FRP should have either a structural/reinforcing role or weight saving role, not just act as an inert filler:
- The mix of materials should be synergistic.
- It should not be merely a novel disposal method such as some component of a geotechnical fill.

- The re-use method should be realistic in respect of the likely volumes of recyclate available.
- The re-use of FRP should not make the ultimate recycling of the product difficult (some types of "plastic wood" can be easily recycled or burned without pollution).
- The product should not pose environmental problems or health and safety problems in use - e.g. from abrasion, wear related loss of glass fibres, or during cutting and drilling.
- The product should not be a substitute for something which is actually made from a more sustainable material in the first instance, such as plantation timber.
- The combination of ground FRP with some other waste material should not divert this waste from an existing higher end re-use chain.
- The product should have a suitably long service life.
- The product should be cost effective.

Waste materials that are "recycled" require some form of significant physical, chemical or biological processing. For example, used paper must be deinked, pulped and re-manufactured before it can be used again.

An important aspect of reuse and recycling in developing countries that differs substantially from practices in developed countries is that developing economies tend to favour more extensive recycling and reuse of materials. On the demand side, the value of raw material inputs tends to be higher and their availability scarcer, thus making recycled or reused materials more attractive. On the supply side, the labour costs associated with separating mixed wastes are also very low. Industrial waste material sorting for the purposes of reuse and recycling is an important income-generating source that can benefit a wide range of actors, including factory owners, factory employees, scavengers, junk buyers, and municipal waste collection employees.
Practical confirmation of the recycling and reuse possibilities of the ECO-PCCM panel composites has been describer in detail in the Deliverable Report No. 9.

Integrated Material Design Framework (IMDF)

The IMDF method emphasizes the tailoring of material properties for specific application where the problem of waste materials will be completely closed.

So, a number of wide ranging disciplines must be brought together for life cycle assessment of the ECO-PCCM construction composite systems. For ECO-PCCM construction composite systems, these disciplines include material research and engineering, civil engineering and architecture, industrial production, environmental policy and economics. Such a team, sponsored by the EU-FP6 program has been assembled at the ECO-PCCM project.

In this project, the framework was specifically tailored to construction (internal) applications, however it may be readily adopted to development of sustainable materials for other industrial applications. The problem of waste was closed by including the waste material as a filler for low-cost construction polymer mortars.

LCA and Eco-Indicators

The use of Life Cycle Assessment (LCA), Eco-Design and Eco-Indicators can aid the construction industry in its search for ecologically friendly products. LCA is a quantitative method to assess the environmental impacts occurring through the product life cycle, covering materials extraction and processing, manufacture, use, disposal and recycling, and has already been applied to the construction industry in the form of BRE Environmental Profiles11. Eco-design takes into consideration the life cycle of the materials used and the methods of interactions they have with the environment. It looks at reducing the environmental impact of a product over its life cycle without impacting on quality. Eco-design concentrates on ensuring that products are easier to disassemble and uses mainly components that are more easily reused or recycled. Using these principles in the design process can increase profitability by eliminating waste at the beginning of the product's life cycle rather than at the end.

LCA and Eco-design can thus feed into any part of the waste hierarchy and are in effect an application of the **Best Practicable Environmental Option (BPEO).** However, Eco-design currently lacks the range and detail of information to make an informed decision for all materials and components. Environmental Profiles and LCA data already exist for many recycling and disposal processes, and provide a mechanism to assess new and experimental techniques. In the frame of ECO-PCCM project the following part of LCA was done.

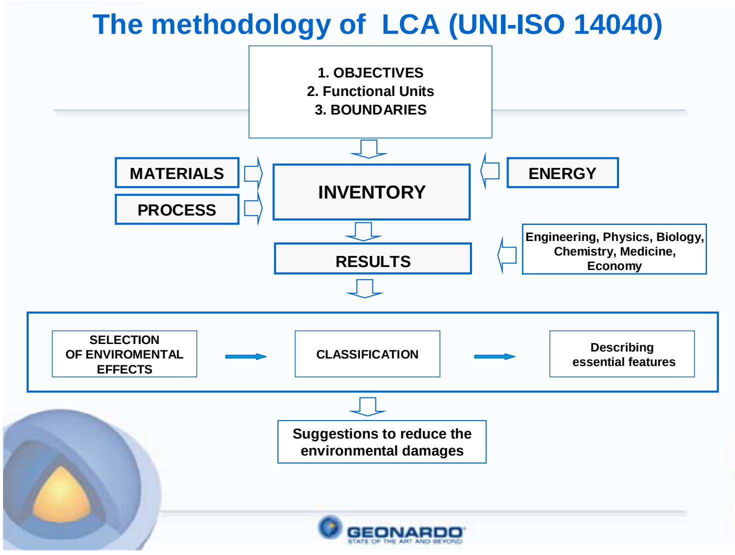


Figure 42: The methodology of LCA

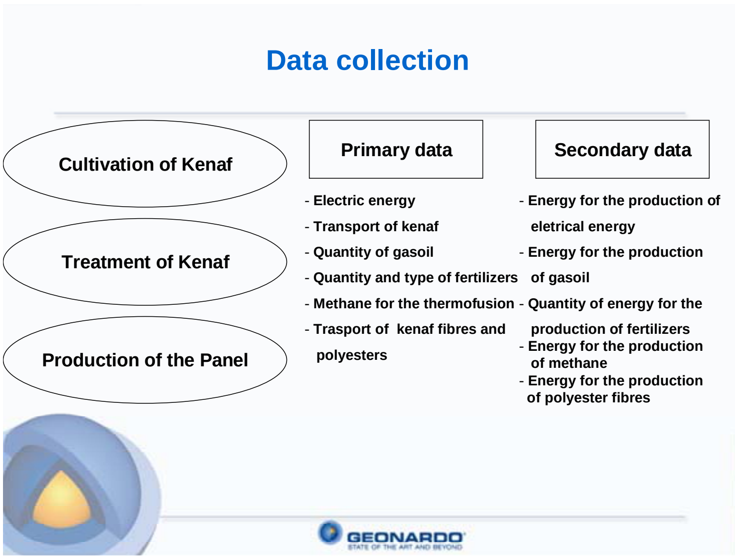


Figure: 43 Data collection

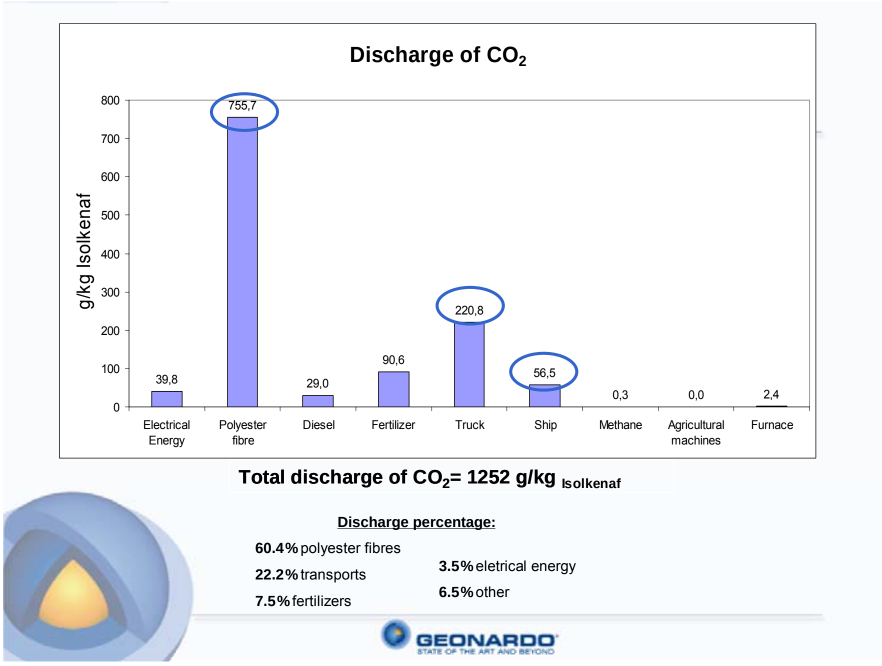


Figure: 44 Discharge of CO2

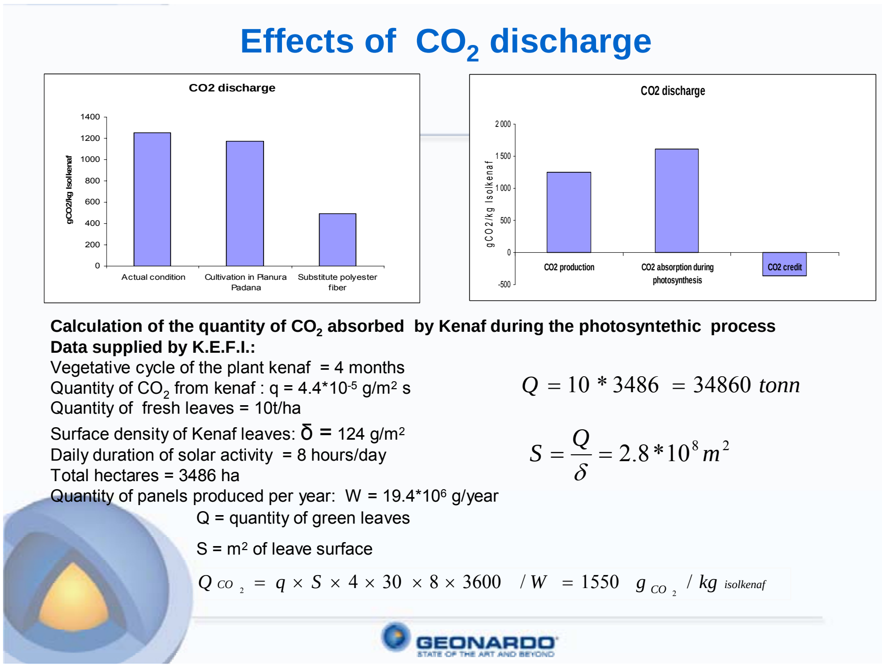


Figure 45: Discharge of CO2

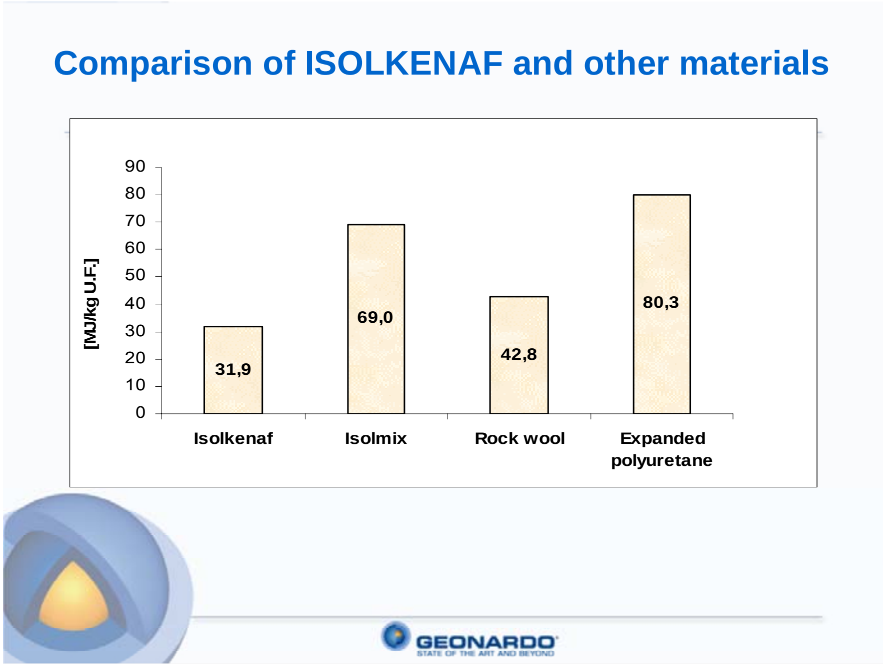


Figure 46: Comparison of Islokenaf and other materials

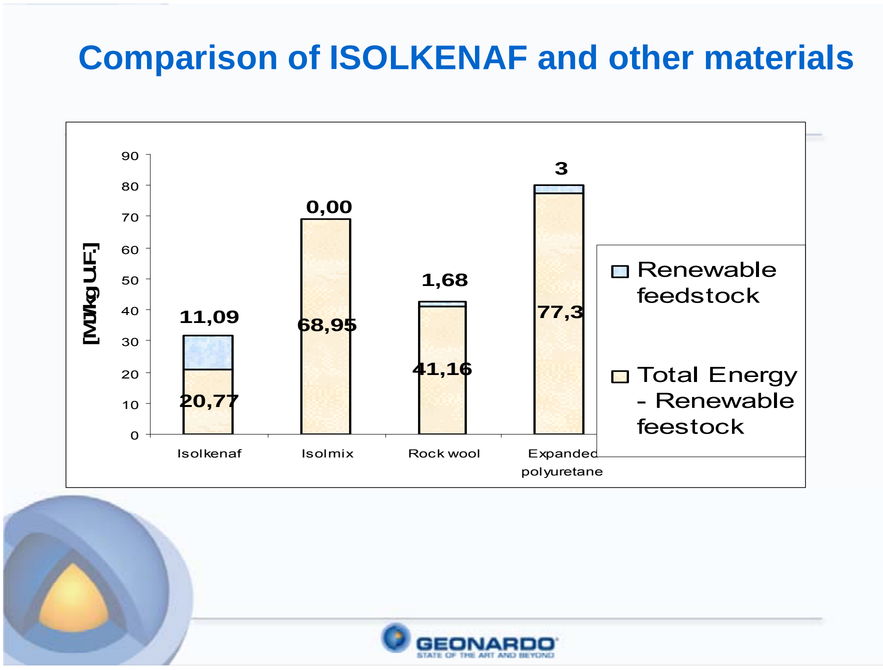


Figure 47: Comparison of Islokenaf and other materials

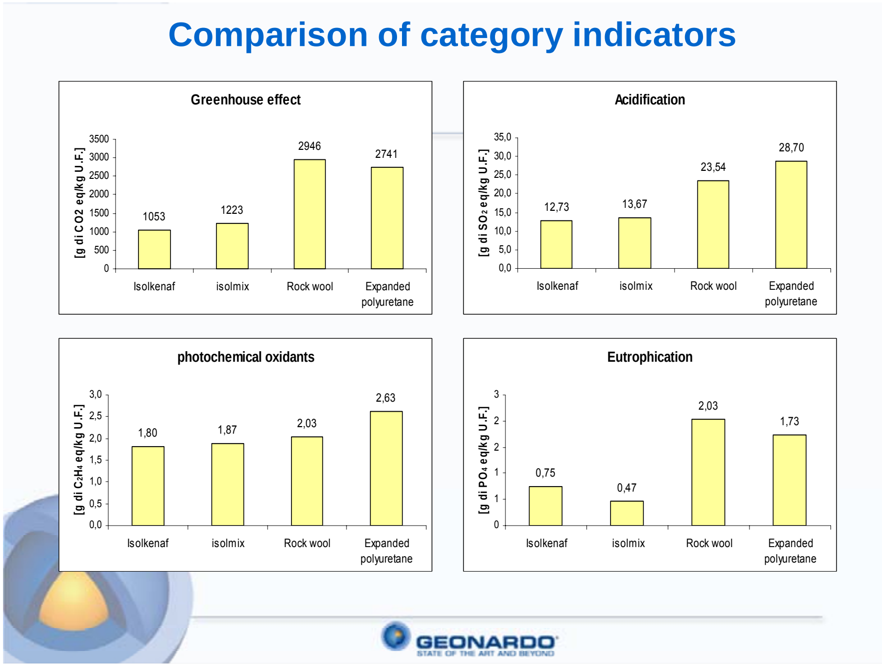


Figure 48: Comparison of eco-indicators

Environmental Waste Management & Plastics Recycling

The Strategy method of Environmental Waste Management & Plastics Recycling includes several type of actions such as:

- Pyrolitic gasification,
- Recovery of monomers,
- Feedstock recycling,
- Tertiary recycling & thermolysis,
- Biodegradation.

Reinforced plastics have a high calorific value therefore incineration with energy recovery is a viable option for ECO-PCCM composite waste. Incinerator operators actually charge more for accepting eco-composite waste because the high calorific content together with toxic emissions tends to overload the system, meaning they cannot process as much domestic refuse. It must be borne in mind that the production of electricity from energy recovery is a secondary concern and that the prime business of the incinerator is to dispose of domestic refuse.

The use of ecocomposites is a growing alternative to FRPs. They use plant fibres as an environmentally friendly and low-cost alternative to glass fibres. Natural fibre eco-composites are from renewable resources and can be composted or incinerated at the end of their life. The European automotive industry is investigating the possibility of using natural fibre reinforced thermoplastics to benefit the environment whilst saving weight (natural fibres are 50% lighter than glass fibres) and cost at the same time.

Natural fibres can easily compete with glass fibres in terms of stiffness, but their tensile, compressive and impact strength are relatively low compared to glass fibres. By modifying the polymer matrix, ecocomposites can be designed to be either stable or biodegradable. As mentioned above, mechanical recycling is preferred over incineration and landfill. However, mechanical recycling of natural fibre composites could prove problematic as they tend to degrade near the processing temperature of most thermoplastics.

Composting is unlikely to be practicable for combinations of natural fibre and resins such as polyester resin. Plenty of clean plant matter from municipal collection of garden waste, together with agricultural waste such as chicken litter is available for the compost industry to use and building components with difficult to separate organic matter will not be considered.

Incineration without energy recovery and landfilling of composites waste are the least preferred options because they result in a loss of the energy content which could be harvested by incineration with energy recovery. Landfilling of composite waste appears to be the most common disposal option at present in the UK because, although on the increase, the cost of disposal of waste is still relatively low. The fate of surplus new or used FRP components depends on the cost effectiveness of the options available. Thus, until landfill taxes increase to a value where recycling or incineration become viable alternatives, or legislation changes, most of the FRP waste produced will end up disposed of in the ground.

T5.3 Development of materials and process for an easy deconstruction-recycling-reuse, selective demolition of eco-houses

The basic characteristics of the elements produced of eco-materials, industrialization of the production, dimensions and systems for building and assemblage enable their wide application. The construction panels with their standardized dimensions are applicable as components for construction of buildings that are built in reinforced steel basic construction. The large buildings with a different application, built in the above mentioned construction systems require forming up of the rooms with an application of the panels that are fitted according to the system of dry assemblage. The panels will be formed up from our eco-materials or in combination with similar construction materials and in accordance with the character of the space that is built up.

The panels for building and forming up the space, and in combination with eco-materials with similar characteristics are applicable when building:

- hotels (perforated panel with a good acoustic protection)
- administrative rooms (panels with good acoustic and thermal characteristics)
- cinema theaters and music halls (panels with good acoustic and fire-resistant characteristics)
- hospitals (with good characteristics regarding the humidity, air, acoustics, protection from electromagnetic and x-rays).

The application of the fitted panels in forming up the rooms compared to the classic materials always enables enlarging of the volume of the space.

When reconstructing the existing buildings, the application of the fitted boards and panels is the most suitable system of building. The materials and elements from the final processing of the space are removed from the building and afterwards the space is formed up with new characteristics and a new look. The space and the buildings are being modernized. The eco-materials which are fitted without an application of water are the most suitable system for building when reconstructing the buildings. The reconstruction of the space means a combination of materials in the construction: the old (existing) ones and the new ones with which the space is formed up. The characteristics of the new construction elements used for the reconstruction of the space are determined regarding the features of the existing construction elements of the building.

When applying the panels for forming up the reconstructed space, the space is enlarged, the conditions regarding the thermal characteristics, acoustics, humidity, as well as the aesthetic characteristics of the building and space are improved.

Deviations and corrective actions

No deviations have to be remarked for this WP.

Deliverables

D8 Methods for the transformation/conversion of solid-plastic waste used to build eco-houses
Delivery date: 36TH month; foreseen delivery date: 36TH month.

D9 Report on reuse and recycling of materials used to build eco-houses
Delivery date: 36TH month; foreseen delivery date: 36TH month.

Deliverables D8 and D9 were delivered on time: 36th month.

Milestones

Methods-guidelines for the waste minimization of eco friendly composites

The only milestone of this WP has been achieved in the due time.

Section 3 – CONSORTIUM MANAGEMENT

Workpackage 6 (WP6) – Project Management

Lead contractor: Partner n 1 – ICTP

Workpackage objectives

a) Project progress control and planning

b) Exploitation and dissemination of Results, Intellectual Property Rights (IPR) securing

c) Interaction with related Project and International Association

The tasks planned for WP6 are briefly reported as follows:

T6.1: Management

T6.2: Exploitation

Progress towards objectives

T6.1: Management

The ECO-PCCM project started on October 1st, 2004, after the signature of the contract by the European Commission.

The coordinator of the project, ICTP, organised a kick off meeting, as it can be observed from the Agenda herewith attached. The meeting was hold on January 20-21, 2005, at the Institute of Chemistry and Technology of Polymers – CNR in Pozzuoli (NA) – Italy.

The 6-month meeting was hold on April 7-8, 2005, at the Institute of Chemistry, Technology and Metallurgy in Belgrade – SCG.

The 3rd meeting (first year meeting) was hold on September 29-30, 2005, at CIDEMCO – Technological Research Centre in Azpeitia (Guipúzcoa), Spain.

The 4th meeting was hold on 6-7 April 2006 in Sofia, Bulgaria, at the Institute of polymers – Bulgarian Academy of science.

The 5th meeting was organized on 4-5 September 2006 in Argentona, Spain. The meeting was organized by Modirect.

The 6th meeting (technical) was hold on 1st of February 2007 in Skopje, Macedonia.

The 7th meeting was hold on 29-30 March 2007 in Budapest, Hungary, at Geonardo.

The 8th meeting was hold on 13-15 September 2007 in Ohrid, Macedonia.

In the next pages the minutes of the meetings organized during the project are reported.

Minute of the kick-off meeting

(20-21 January, 2005 Pozzuoli, Naples, Italy)

On January 20-21, 2005 the kick-off meeting of the European Project ECO-PCCM (ECO- HOUSES BASED ON ECO-FRIENDLY POLYMER COMPOSITE CONSTRICTION MATERIALS) - Contract n. INCO-CT-2004-509185 was hold at the Institute of Chemistry and Technology of Polymers – CNR in Pozzuoli (NA) – Italy.

After the presentation of all the partners, the discussion was focused on the formation of the Steering Committee and the Technical and Administrative Committee, as well as to the nomination of the Exploitation Manager.
Members of the Steering Committee are one senior leader for each partner responsible for at least one of the project workpackages, and the Exploitation manager.

EXPLOITATION MANAGER:
Anita GROZDANOV (TMF)

STEERING COMMITTEE

1. Maurizio AVELLA	ICTP-CNR, CHAIRMAN
2. Gordana BOGOEVA-GACEVA	TMF, Coordinator of WBC partners
3. Javier GARCIA-JACA	CIDEMCO
4. Dimko DIMESKI	EUROKOMPOZIT
5. Balas BODO	GEONARDO
6. Anita GROZDANOV	TMF, Exploitation Manager

TECHNICAL AND ADMINISTRATIVE COMMITTEE

1. Maurizio AVELLA	ICTP-CNR
2. Miriam GARCIA	CIDEMCO
3. Xavier Busques Carlota	MONDIRECT
4. Valerio ZUCCHINI	KEFI
5. Gordana BOGOEVA-GACEVA	TMF
6. Dimko DIMESKI	EUROKOMPOZIT
7. Aleksandar DEKANSKI	ICTM
8. Zlatan MANOV	USKIM
9. Nenad RADJENOVIC	STUDIO R
10. Teodora GRNCAROVSKA	MOEPP
11. Attila UDERSZKI	GEONARDO
12. Emanuel NEDKOV	IPBAS

Then, the discussion was focused on the research activity for the next months. In particular it was decided that the research work will be developed on the following materials:

Fiber/filler selection:
kenaf, recycled paper, cotton, rice straw
hemp (only for lab-scale)
Polymer matrices:
PLA, PHBV, PHB, PP (as reference), PET (as reference)

Fiber/matrix ratio:
1. 80-90 % fibre / 20-10 % matrix (in the form of fibre or liquid, etc.)
2. 20-30 % fibre / 80-70 % matrix (in the form of fibre or liquid, etc.)

The Partners Tasks for the first six months of WP1 (T1.1. and T1.2) will be the following:

1. ICTP – Research on cellulose and kenaf systems; production and characterization of the composite samples and of the fiber/matrix interface; state-of-the-art of NFC
2. KEFI – Delivering the fibre preforms to the partners: ICTP, TMF, EUROKOMPOZIT, CIDEMCO
3. TMF – Research on kenaf, cotton, rice systems; lab-scale experiments and characterization of the composite samples and of the fiber/matrix interface; state-of-the-art of NFC
4. EUROKOMPOZIT – Production of the composite samples
5. CIDEMCO – Production and characterization of the composite samples; fire resistance analysis; state-of-the-art of eco-friendly fire retardants
6. ICTM – Characterization of the fibres and the composites
7. IPBAS – Characterization of the fibres and the composites
8. USKIM – Characterization of NFC and comparison with traditional materials in use
9. MONDIRECT – Review on the machinery that could be used for NFC
10. MOEPP – Review on the EU Legislation and Macedonian needs; proposal of indicators for sustainable development
11. GEONARDO – Report on EU Legislation that should be applied for eco-houses
12. STUDIO R – Vision of eco-house from the architects point of view; possibilities of the software in design of eco-houses: determination of the inputs in the software in order to get required output.

As concerning the dissemination actions, two reviews will be prepared, included in the report and published.
The consortium agreement was signed by all the partners.

Finally, it was fixed that the next meeting will take place on 7-8 April 2005, in Belgrade (SCG).

KICK-OFF MEETING

AGENDA OF 20/01/05

Part I
MORNING SESSION (starting time: 10:30)

Presentation by	Agenda item	Remark	Typical time
Host Institute: ICTP Director: Prof. Cosimo Carfagna	Welcome		10 min
Italian Responsible for INCO program Dr. Elena De Simone	Welcome		10 min
Coordinator Dr. Maurizio Avella	Presentation	Review/explanation of project	15 min
Prof. Gordana Bogoeva-Gaceva (TMF)	Presentation	Chronology of the project application	15 min
Project partners	Presentation	Presentation of each partner's organization	5 min for each partner

LUNCH (starting time 12:30)

Part II
AFTERNOON SESSION (starting time14:00)

Presentation by	Agenda item	Remark	Typical time
ICTP		Tour of ICTP laboratories	60 min
Dr. Anita Grozdanov (Part. 5 - TMF)	Project overview	Working packages of the project	30 min
Dr. Maurizio Avella Dr. Mario Malinconico (Part. 1 - ICTP)	Presentation	Natural fibre composites – the experience of ICTP	20 min
Dr. Aleksandra Buzarovska (Part. 5 - TMF)	Presentation	Comparison of different polymer matrices proposed in the project	10 min
Dr. Anita Grozdanov (Part. 5 - TMF)	Presentation	Choice of natural fibres for reinforcing polymer composites	10min
Dr. Javier Garcia-Jaca (Part. 2 - CIDEMCO)	Presentation	Critical testing of natural fibre composites	10 min
Dr. Xavier Busques Carlota (Part. 3 - MONDIRECT)	Presentation	Processing of plastics and natural fibre composites	10 min
Dr. Valerio Zucchini (Part. 4 - KEFI)	Presentation	Natural fibres preforms and production	10 min
Dr. Dime Dimeski Dr. Zlatan Manov (Part. 6, 8 - EUROKOMPOZIT, USKIM-ZIMRANT)	Presentation	I. Production procedures in EUROKOMPOZIT II. Construction materials and standards	10 min

SOCIAL DINNER (starting time 20:00)

AGENDA OF 21/01/05

PART III
MORNING SESSION (starting time: 9:00)

Presentation by	Agenda item	Remark	Typical time
Dr. Emanuel Nedkov (Part. 12 - IPBAS)	Presentation	IPBAS – polymers and composite characterisation	10 min
Mr. Nenad Radjenovic (Part. 9 - Studio R)	Presentation	Software support for design of eco-houses	10 min
Mrs. Teodora Grncarovska (Part. 10 - MOEPP)	Presentation	EU legislative for sustainable development – Macedonian needs	10 min
Mr. Attila Uderszky (Part. 11 – GEONARDO)	Presentation	Application of EU eco-legislation	10 min
Dr. Aleksandar Dekanski (Part. 7 - ICTM)	Presentation	Promotion of the preliminary version of the project Web-site	10 min
Coffee Break 9:50-10:00			
All Participants	Work plan	Agree of timetable, co-operation and technical details of the tasks to be carried out during the first semester and the relevant deliverables	60 min
All Participants	Exploitation	Review of exploitation potential Dissemination of results including plans for future publications	30 min
Coordinator Dr. Maurizio Avella	Management Resources	Review of management structure and decision making mechanisms Review of finances and manpower situation	30 min
Coordinator Dr. Maurizio Avella	Conclusion	Participation ECO-COMP 2005, June 20-21 Sweden Mobility between the partners in 2005 Fixing of next Meeting	30 min

CLOSURE OF THE MEETING

PRESENCES AT THE KICK-OFF MEETING

	NAME	INSTITUTION	SIGNATURE
1	Maurizio AVELLA	ICTP	
2	Anita GROZDANOV	TMF	
3	Emanuel NEDKOV	IPBAS	
4	Zlatan MANOV	USKIM	
5	Dimko DIMESKI	EUROKOMPOZIT	
6	Attila UDERSZKI	GEONARDO	
7	Balas BODO	GEONARDO	
8	Miriam GARCIA	CIDEMCO	
9	Javier BUSQUES	MONDIRECT	
10	Sanja RADJENOVIC	STUDIO R	
11	Teodora GRNCAROVSKA	MOEPP	
12	Nenad RADJENOVIC	STUDIO R	
13	Maria Emanuela ERRICO	ICTP	
14	Lucia D'ARIENZO	CAMPEC	
15	Gabriella SANTAGATA	ICTP	
16	Mariacristina COCCA	CAMPEC	
17	Emilia DI PACE	ICTP	
18	Barbara IMMIRZI	ICTP	
19	Maria Laura DI LORENZO	ICTP	
20	Mario MALINCONICO	ICTP	
21	Gordana BOGOEVA	TMF	
22	Aleksandar DEKANSKI	ICTM	
23	Valerio ZUCCHINI	KEFI	

(Original available to the EC)

Minute of the 6-month technical meeting

(7-8 April, 2005, Belgrade, SCG)

On April 7-8, 2005 the 6-month meeting of the European Project ECO-PCCM (ECO-HOUSES BASED ON ECO-FRIENDLY POLYMER COMPOSITE CONSTRICTION MATERIALS) - Contract n. INCO-CT-2004-509185 was hold at the Institute of Chemistry, Technology and Metallurgy in Belgrade – SCG.

CONCLUSIONS

Fibre selection: kenaf, cotton, cellulose, rice straw

Polymer matrix: PLA, PHB, PHBV, PP and PET (as references)

The tasks assigned to each Partner for the next 6 months of activities have been established as follows:

Partner 1 (ICTP) will continue the research activities on Kenaf-PLA composites.

ICTP will provide to the other partners (TMF, Partner 5, ICTM, Partner 7, and CIDEMCO, Partner 2), small composite samples realized at lab scale in order to allow these partners to perform specific characterizations.

Furthermore, ICTP will deliver PLA, PHB and PHBV samples to TMF (Partner 5) and ICTM (Partner 7).

Partner 2 (CIDEMCO) will perform ageing cycles and mechanical and fire-retardant tests of NFC delivered by KEFI (Partner 4) and ICTP (Partner 1).

Furthermore, CIDEMCO will deliver composite samples treated with fire-retardants to IP-BAS (Partner 11).

Partner 3 (MONDIRECT) will continue the activities aimed to set-up the machinery that could be used for production of NFC.

Furthermore, MONDIRECT, will prepare lab-scale samples of PLA-Rice straw to be delivered to the other partners for the characterization.

Partner 4 (KEFI) will deliver kenaf-PLA preforms realized on the industrial plant to all partners for the characterisation.

Furthermore, KEFI will collect price information for PLA fibres as well as for the kenaf based preforms and will deliver these information to MOEPP (Partner 9), GEONARDO (Partner 12) and TMF (Partner 5).

Partner 5 (TMF) will continue the activities of investigation of eco-friendly composites on lab-scale, based on PLA and cotton, cellulose and rice straw. In particular, TMF will focus the researches on the characterization of fiber-matrix interface.

Partner 6 (EUROKOMPOZIT) will produce and characterize PP/kenaf preforms with different matrix ratio (unfinished task from first 6 months) and new Kenaf-PLA samples.

Partner 7 (ICTM) will characterize natural fibres (NF) and NF composites by SEM and WAX analysis.

Furthermore ICTM will manage and update the web-site of the project.

Partner 8 (USKIM) will continue the activities aimed at studying NFC by means mechanical characterization.

Partner 9 (MOEPP) will collect data from the relevant partners for preliminary analysis of Composite Indicators for the evaluation of sustainability and 3P (Price/Performance/Properties) ratio of eco-friendly composites.

Partner 10 (STUDIO R) will design interior partitioning panels constituted by NF composites and will report on target properties and parameters of selected parts of eco-house.

Partner 11 (IPBAS) will continue the researches on kinetics and thermodynamic parameters of crystallization of PLA and related composites.

Partner 12 (GEONARDO), in cooperation with MOEPP (Partner 9), will collect data from the relevant partners for preliminary analysis of Composite Indicators for sustainability of eco-friendly composites.

Short term task for each partner:

Delivering of short report on the first six months activities performed in the framework of the project to the coordinator Dr. Maurizio Avella and INCO-countries coordinator Prof. Gordana Bogoeva-Gaceva. Deadline 15.04.2005.

Dissemination:

- Poster presentations at ECO-COMP 2005 Conference in Stockholm, Sweden
- Two reviews (to be included in the report)

Next meeting:

29-30 September 2005, organizer CIDEMCO – Azpeitia, Spain

First Year Report:

At the end of October, 2005

6^{TH} MONTH TECHNICAL MEETING

AGENDA OF 07/04/05

Part I: MORNING SESSION (starting time: 13:00)

Presentation by	Agenda item	Remark	Typical time
Representative of the Ministry of Science and Environmental Protection of Serbia: Dr. Ilija Videnović	Welcome		5 min
Host Institute: ICTM Director: Dr Milan Dabović	Welcome		5 min
Host Institute: ICTM– Dept. of Electrochemistry Director: Dr Amalija Tripković	Welcome		5 min
ICTP Coordinator: Dr. Maurizio Avella	Introduction	Topics of the Meeting First Semester Overview	15 min

LUNCH (starting time 13:45)

Part II: AFTERNOON SESSION (starting time14:00)

Presentation by	Results survey	Typical time
ICTP Maurizio Avella	Research on Cellulose and Kenaf systems	15 min
TMF Gordana Bogoeva-Gaceva	Kenaf/Polypropylene composites: Innovations/Commercialization/ Research Work/ECO-PCCM directions	15 min
TMF Anita Grozdanov	Investigation on model PP composites with kenaf fibres and recycled paper (DSC, POM)	15 min
TMF Aleksandra Buzarovska	Investigation on model PHB composites with kenaf fibres and recycled paper	15 min
CIDEMCO Míriam García	Production and characterization of the composite samples; Fire resistance analysis, State-of-the-art of eco-friendly fire retardants	15 min
MONDIRECT Xavier Busques Carlota	Review on the machinery that could be used for NFC	15 min
Coffee Break 9:50-10:00		
EUROKOMPOZIT Dime Dimeski	Production and characterization of kenaf fibre –PP composites	15 min
USKIM Zlatan Manov	Preliminary comparison of PP-kenaf composites with traditional materials in use	15 min
Project partners	Results Discussion, Creation of the Conclusion and Preparation of the Preliminary Version of the First Report	45 min
ICTP Coordinator: Maurizio Avella	Summary of the first day	5 min

SOCIAL DINNER (starting time 20:00)

AGENDA OF 08/04/05

Part III: MORNING SESSION (starting time: 9:00)

Presentation by	Results survey	Typical time
STUDIO R Nenad Radjenovic	Possiblities of the software in design of eco- houses: Determination of the inputs in the software in order to get required output	15 min
ICTM Aleksandar Dekanski	News about project web-site	15 min
GEONARDO Attila Uderszky	EU Legislation that should be applied for eco- houses	15 min
MOEPP Teodora Obradovic	Review on the EU Legislation and Macedonian needs; indicators for sustainable development	15 min
ICTP Coordinator: Maurizio Avella	Final Version of the First Report	60 min
Coffee Break 11:00-11:15		
TMF Anita Grozdanov	Recommendations for the improvement of the future work	15 min
All Participants	Exploitation Results: Dissemination and Publishing	30 min
All Participants	Work plan Agree of timetable, co- operation and technical details of the tasks to be carried out during the second semester and the relevant deliverables	45 min
ICTP Coordinator: Maurizio Avella	Management Review of finances and manpower situation	15 min
ICTP Coordinator: Maurizio Avella	Conclusion Mobility between the partners in 2005 Fixing of next Meeting	15 min

LUNCH (starting time: 14: 00)

CLOSURE OF THE MEETING

PRESENCES AT THE 6TH MONTH TECHNICAL MEETING

	NAME	INSTITUTION	SIGNATURE
1	Anita GROZDANOV	TMF	Anita Grozdanov
2	Gordana BOGOEVA-GACEVA	TMF	Gordana Bogoeva-Gaceva
3	Aleksandra BUZAROVSKA	TMF	[illegible]
4	Zlatan MANOV	USKIM	ZLATAN MANOV
5	Javier BUSQUES	MONDIRECT	Javier Busques
6	Miriam GARCIA	CIDEMCO	MIRIAM GARCIA
7	Nenad RADJENOVIC	STUDIO R	RADJENOVIĆ NENAD
8	Sanja RADJENOVIC	STUDIO R	RADJENOVIC JOVANOVIC SANJA
9	Gennaro GENTILE	ICTP	GENNARO GENTILE
10	Maria Emanuela ERRICO	ICTP	MARIA EMANUELA ERRICO
11	Vineta SREBRENKOSKA	EUROKOMPOZIT	Vineta SREBRENKOSKA
12	Valerio ZUCCHINI	KEFI	VALERIO ZUCCHINI
13	Attila UDERSZKI	GEONARDO	ATTILA UDERSZKY
14	Emanuel NEDKOV	IPBAS	Emanuel Nedkov
15	Vladmir PANIC	ICTM	Vladimir Panić
16	Aleksandar DEKANSKI	ICTM	ALEKSANDAR DEKANSKI
17	Dimko DIMESKI	EUROKOMPOZIT	DIME DIMESKI
18	Maurizio AVELLA	ICTP	[illegible]

(Original available to the EC)

Minute of the 1st year technical meeting

(29-30 September, 2005, Azpeitia ,Guipúzcoa, Spain)

On September 29-30, 2005 the 1st year meeting of the European Project ECO-PCCM (ECO-HOUSES BASED ON ECO-FRIENDLY POLYMER COMPOSITE CONSTRICTION MATERIALS) - Contract n. INCO-CT-2004-509185 was hold at CIDEMCO – Technological Research Centre in Azpeitia (Guipúzcoa), Spain.

CONCLUSIONS

Partners tasks for the next sixth months of WP2

1. ICTP

- Research on kenaf-PLLA composites (kenaf fibre content: 20, 30 %)
- Improvement of fibre distribution
- Improvement of fiber-matrix adhesion
- Characterization of the composites

2. CIDEMCO

- Selection of appropriate non-halogen fire retardant agents and delivering to KEFI (as liquid)
- Aging, abrasion resistant, mechanical and fire-retardant testing of NFC delivered by KEFI and ICTP
- Delivering of non-halogen fire retardant agents to TMF for possible application in rice straw based composites.

3. MONDIRECT

- Set-up of the machinery that could be used for production of NFC
- Preparation of pellets/granules of rice straw/PP and PLA

4. KEFI

- Delivering of kenaf/PLLA preforms (various fibre/polymer ratio) to Eurokompozit
- An attempt to prepare rice straw/PP and PLA preforms
- Delivering of the data necessary for calculation of eco-indicators

5. TMF

- Investigation of composites based on PLA, PP,
- Further optimization of rice straw based composites
- Improvement and characterization of fiber-matrix interface

6. EUROKOMPOZIT

- Characterization of kenaf/PLLA composites (unfinished task)
- Production and characterization of kenaf composites with different matrix content delivered by KEFI
- Optimization of the industrial processing conditions
- Production of samples 70x70x5cm and delivering to USKIM for λ measurements
- Delivering of the data necessary for calculation of Eco-indicators

7. ICTM

- Characterization of NF and NFC (SEM, WAX)
- WEB activities

8. USKIM

- Physical-mechanical characterization of NFC
- Thermal and acoustic characterization of the ECO-PCCM products

9. MOEPP

- Collecting data from the relevant partners for preliminary analysis of Composite Indicators for sustainability of eco-friendly composites
- Methods and techniques for calculations of the eco-indicators

10. STUDIO R

- Design of interior partitioning panels and various elements for eco-houses
- Report on target properties and parameters of selected parts of eco-house
- Report on the methods for the assessment and optimization of housing comfort

11. IP-BAS

- Investigation of influence of natural fibres on crystallization parameters of PLLA and PHBV,
- Micro-hardness of polymer matrices and NF composites
- Investigation of the morphology in NFC by OM

12. GEONARDO

- Collecting data from the relevant partners for preliminary analysis of Composite Indicators for sustainability of eco-friendly composites
- Methods and techniques for calculations of the eco-indicators

TECHNICAL MEETINGS FORESEEN

- Joint task for partners 9 and 12: Technical meeting with Prof. Glavac (Slovenia) in Skopje, November 2005
- Next meeting in Sofia, April 6-7, 2006

OTHER REMARKS

All the partners have to deliver to the coordinator the following documents (in electronic format) before Friday, October 7, 2005:

- form C
- periodic activity report
- periodic financial report

1st YEAR TECHNICAL MEETING
AGENDA OF SEPTEMBER 29, 2005

Morning Session (starting time 9.40)

Presentation by	Agenda item	Remark	time
CIDEMCO Head of Mat. Dept. Javier García Jaca	Welcome		5 min
Coordinator: Maurizio Avella	Introduction	Topics of the meeting Second semester overview	15 min
ICTP Gennaro Gentile	Presentation	Research on Kenaf-PLA composites	15 min
TMF Anita Grozdanov	Presentation	Investigation on rice-straw based composites	15 min
TMF-ICTM Anita Grozdanov	Presentation	Characterization of fiber-matrix interface	15 min
IPBAS Emanuel Nedkov	Presentation	Characterization and kinetics and thermodynamic parameters of crystallization of PLA	15 min
Coffee break 11.00-11.30			
USKIM Zlatan Manov	Presentation	Characterization of natural fibre composites	15 min
CIDEMCO Miriam Garcia	Presentation	Testing of kenaf/PLA compounds	15 min
MONDIRECT Xavier Busques	Presentation	Set-up of the machinery to be used on eco-friendly composites	15 min
EUROKOMPOZIT Dime Dimeski	Presentation	Production and characterization of PP/Kenaf and Kenaf/PLA composites	15 min
STUDIO R Nenad Radjenovic	Presentation	Design of interior partitioning panels. Target properties and parameters of selected parts of eco-houses	15 min
GEONARDO Attila Udersky	Presentation	Analysis of Composite Indicators for sustainability of eco-friendly composites	15 min
MOEPP Teodora Obradovic	Presentation	Analysis of Composite Indicators for sustainability of eco-friendly composites	15 min
ICTM Aleksandar Dekanski	Presentation	On-going of the web page	15 min
TMF Gordana Bogoeva-Gaceva	Presentation	Innovations/Commercialization/Research Work/ECO-PCCM future directions?	15 min

LUNCH TIME (starting time: 13.45)

Afternoon session (Starting time: 14.45)

Presentation by	Agenda item	remark	time
Project Partners	Results	Discussion of results and conclusions	45 min
Coordinator: Maurizio Avella	Summary and report	Summary of the day. Preparation of the Report	60 min

SOCIAL DINNER
(meeting time at the hotel: 20.30, (starting time: 21.00)

AGENDA OF SEPTEMBER 30, 2005

Morning Session (starting time 10.00)

Presentation by	Agenda item	Remark	time
CIDEMCO	Tour of CIDEMCO		60 min
Coffee Break 11.00-11.30			
Project Partners	Work Plan	Agree of timetable, co-operation and technical details of the tasks to be carried out during the third semester and the relevant deliverables	45 min
Project Partners	Exploitation	Exploitation of results: dissemination and publishing	15 min
Coordinator: Maurizio Avella	Management	Review of management structure and man-month data	15 min
Coordinator: Maurizio Avella	Conclusion	Mobility between the partners in 2005. Fixing of next meeting	15 min

LUNCH TIME (starting time: 13.00)

CLOSURE OF THE MEETING

PRESENCES AT THE 1st YEAR TECHNICAL MEETING

	NAME	INSTITUTION	SIGNATURE
1	Anita GROZDANOV	TMF	
2	Maurizio AVELLA	ICTP	
3	Gennaro GENTILE	ICTP	
4	Maria Emanuela ERRICO	ICTP	
5	Attila UDERSZKI	GEONARDO	
6	Emanuel NEDKOV	IPBAS	
7	Javier GARCIA-JACA	CIDEMCO	
8	Zlatan MANOV	USKIM	
9	Aleksandar DEKANSKI	ICTM	
10	Valerio ZUCCHINI	KEFI	
11	Nenad RADJENOVIC	STUDIO R	
12	Sanja RADJENOVIC	STUDIO R	
13	Gordana BOGOEVA-GACEVA	TMF	
14	Miriam GARCIA	CIDEMCO	
15	Teodora GRNCAROVSKA	MOEPP	

(Original available to the EC)

Minute of the 4th meeting

(6-7 April 2006, Sofia, Bulgaria)

On April, 6-7, 2006 the 4th meeting of the European Project ECO-PCCM (ECO-HOUSES BASED ON ECO-FRIENDLY POLYMER COMPOSITE CONSTRICTION MATERIALS) – Contract n. INCO-CT-2004-509185 was hold at the Institute of Polymers of Bulgarian Academy of Science, in Sofia – Bulgaria.

CONCLUSIONS

Partner tasks for the next sixth months of WP3 and WP5

1. ICTP:

WP3: Design and application of new bio-polymer based foams

WP5: Development and design of recycling-reuse facilities for transformation of solid plastic waste into polymer mortars for the low-cost building industry

2. CIDEMCO:

WP3: Design and application of new bio-polymer based foams

WP5: Development and design of recycling-reuse facilities for transformation of solid plastic waste into polymer mortars for the low-cost building industry

- Application of various eco-fire retardant agents
- Delivering of eco-fire retardant agents to P.5-TMF for improvement of fire-resistance of rice straw based composites

3. MONDIRECT:

- Set-up of the machinery that could be used for production of NFC
- Preparation of pellets/granules of PLA and PP/kenaf and rice straw

WP5 Extrusion of produced composites (in order to investigate the possibility of recycling and reuse)

4. KEFI:

WP3: Application of new bio-polymer components for improvement of thermal and acoustic insulation of the eco-composites

WP5: Development and design of recycling-reuse facilities for transformation of solid plastic waste into polymer mortars

- Delivering of kenaf-PLLA preforms with increased amount of PLA (70%) to EUROKOMPOZIT for pressing
- Preparation of rice straw/PP and PLLA preforms
- Delivering of price list for PLLA fibers as well as for the kenaf based preforms to MOEPP and TMF Skopje
- Delivering of the data necessary for calculation of Eco-indicators

5. TMF:

WP3: Design of different composites and polymer components for improved thermal and acoustic insulation

WP5: Development and design of recycling-reuse of composite components

- Further optimization of rice straw based composites
- Improvement and characterization of fiber-matrix interface

6. EUROKOMPOZIT:

WP3: Industrial processing of composite panels with thermal and acoustic insulation properties

WP5: Development and design of recycling-reuse of composite components Development of polymer mortars based on solid plastic waste as a matrix

7. ICTM:

WP3 and WP5:

- Characterization of NF and NF composites (SEM,WAXS,…)
- WEB activities

8. USKIM:

WP3 and WP5:

- Application of ECO-PCCM in combination with other commercial construction materials
- Physico-mechanical, thermal and acoustic characterization of the obtained materials

9. MOEPP:

WP3: Methods for the assessment and the optimization of housing comfort: natural light availability, indoor quality, ventilation, odor nuisances, *etc.*

Methods and techniques for calculations of the ECO-indicators

WP5: Environmental service in development of materials and process that allow easy deconstruction-recycling-reuse, selective demolition of eco-house

10. STUDIO R:

WP5: Architectural service in development of materials and process that allow easy deconstruction-recycling-reuse, selective demolition of eco-house

- Design of interior partitioning panels
- Report on the methods for the assessment and optimization of housing comfort

11. IP-BAS:

WP3 and WP5:

- Characterization of NF and NF composites (SEM,WAXS,…)
- WAXS analysis of eco-polymer matrices
- Micro-hardness of eco-polymer matrices and NF composites
- O.I. of the composites and phosphorous content

12. GEONARDO:

WP3: Methods for the assessment and the optimization of housing comfort: natural light availability, indoor quality, ventilation, odor nuisances, *etc.*

- Methods and techniques for calculations of the ECO-indicators

WP5: Environmental service in development of materials and process that allow easy deconstruction-recycling-reuse, selective demolition of eco-house

Next meeting in Barcelona, 4-6 September 2006

4^{TH} MEETING - AGENDA

(6-7 April, 2006 Sofia, Bulgaria)

06/04/06 MORNING SESSION (starting time: 11:30)

Presentation by	Agenda item	Remark	Typical time
Host Institute: IP-BAS Director	Welcome		10 min
Coordinator Maurizio Avella	Presentation	I year report, remarks and notes	15 min
ICTP Gennaro Gentile	Presentation	Characterization of Kenaf/PLLA composites	15 min
TMF Anita Grozdanov	Presentation	Comparison of PP/Cotton composites with other PP/natural fiber composites	10 min
TMF Aleksandra Buzarovska	Presentation	Crystallization behavior of PHBV/Kenaf systems	15 min
EUROKOMPOZIT Vineta Srebrenkoska	Presentation	Characterization of kenaf/PLLA composites	15 min
IP-BAS Maja Staneva	Presentation	Investigation of influence of natural fibers on crystallization of PLLA and PHBV	15 min
IP-BAS Tanja Dobreva	Presentation	Microhardness of polymer matrices and NF composites	15 min

LUNCH (starting time 13:30)

06/04/06 AFTERNOON SESSION (starting time14:30)

Presentation by	Agenda item	Remark	Typical time
KEFI Valerio Zucchini	Presentation	Some technical data of some kenaf/polymer materials	15 min
CIDEMCO Miriam Garcia	Presentation	Aging, abrasion resistant, mechanical and fire-retardant testing of NFC delivered by KEFI and ICTP	15 min
STUDIO R Sanja Radjenovic	Presentation	Design of interior partitioning panels and various elements for eco-houses or Report on target properties and parameters of selected parts of eco-house	15 min
USKIM-ZIMRANT Zlatan Manov	Presentation	Construction materials and standards	10 min

SOCIAL DINNER (starting time 20:00)

06/04/06 MORNING SESSION (starting time: 09:00)

Presentation by	Agenda item	Remark	Typical time
MOEPP Teodora Grncarovska	Presentation	Methods and techniques for calculations of the ECO-indicators	15 min
GEONARDO Attila Uderszky	Presentation	Methods and techniques for calculations of the ECO-indicators	15 min
ICTM Aleksandar Dekanski	Presentation	On-going of the Web-site Activities	10 min
COFFEE BREAK (11:00 - 11:15)			
All Participants	Work plan	Timetable, co-operation and technical details of the tasks to be carried out during the next semester and relevant deliverables	60 min
Anita Grozdanov	Dissemination	Dissemination of results in the III semester including plans for future publications	15 min
Anita Grozdanov	Work plan	IV semester project activities of ECO-PCCM	
Coordinator Maurizio Avella	Management	Review of management structure and decision making mechanisms	15 min
Coordinator Maurizio Avella	Conclusion	Mobility between the partners in 2006 Fixing of next Meeting	30 min

CLOSURE OF THE MEETING

PRESENCES AT THE 4th MEETING IN SOFIA

	NAME	INSTITUTION	SIGNATURE
1	Anita GROZDANOV	TMF	Anita Grozdanov
2	Gordana BOGOEVA-GACEVA	TMF	Gordana Bogoeva-Gaceva
3	Aleksandra BUZAROVSKA	TMF	[illegible]
4	Zlatan MANOV	USKIM	ZLATAN MANOV
5	Miriam GARCIA	CIDEMCO	MIRIAM GARCIA
7	Nenad RADJENOVIC	STUDIO R	RAĐENOVIĆ NENAD
8	Sanja RADJENOVIC	STUDIO R	RADJENOVIC JOVANOVIC SANJA
9	Gennaro GENTILE	ICTP	GENNARO GENTILE
10	Maria Emanuela ERRICO	ICTP	MARIA EMANUELA ERRICO
11	Vineta SREBRENKOSKA	EUROKOMPOZIT	Vineta SREBRENKOSKA
12	Valerio ZUCCHINI	KEFI	VALERIO ZUCCHINI
13	Attila UDERSZKI	GEONARDO	ATTILA UDERSZKY
14	Emanuel NEDKOV	IPBAS	Emanuel Nedkov
15	Aleksandar DEKANSKI	ICTM	ALEKSANDAR DEKANSKI
16	Dimko DIMESKI	EUROKOMPOZIT	DIME DIMESKI
17	Maurizio AVELLA	ICTP	[illegible]
18	Javier BUSQUES	MONDIRECT	Javier Busques

(Original available to the EC)

Minute of the 5th meeting

(4-5 September 2006, Argentona, Spain)

On September, 4-5, 2006 the 5th meeting of the European Project ECO-PCCM (ECO-HOUSES BASED ON ECO-FRIENDLY POLYMER COMPOSITE CONSTRICTION MATERIALS) - Contract n. INCO-CT-2004-509185 was hold in Argentona- Barcelona- Spain.

CONCLUSIONS

Partner tasks for the next sixth months of WP3, WP4 and WP5

1. ICTP:

Development and design of recycling-reuse facilities for transformation of solid plastic waste into polymer mortars/cements for the low-cost building industry

2. CIDEMCO:

- Preparation of the complete formulation polymer/fibers/additives for composite pellets. (Discussion from previous meeting: nanoclay, $Mg(OH)_2$, $Al(OH)_3$)
- Development and design of recycling-reuse facilities for transformation of solid plastic waste into polymer mortars/cements for the low-cost building industry

3. MONDIRECT:

- Set-up of the machinery that could be used for production of NFC, including cutting knifes for pellets
- Production of large amount of pellets of PLA and PP/kenaf and rice straw, and delivery to EUROKOMPOZIT for pressing of panels for thermal and acoustic properties

The pellets should contain additives as suggested by CIDEMCO (biocides, fire-retardants, etc.)

- Delivering of kenaf-PLA pellets with 70% of PLA to EUROKOMPOZIT for pressing (unfinished task)

4. KEFI:

- Production and delivering of new fiber performs (fiber mixtures of kenaf and hemp) with PLA and PP in fiber form

- Delivering of the data necessary for calculation of eco-indicators

5. TMF:

- Development and design of recycling-reuse of composite components
- Development of polymer mortars based on solid plastic waste as a matrix
- Surface treatment of rice straw

6. EUROKOMPOZIT:

- Processing of composite panels
- Characterization of mechanical properties

7. ICTM:

- Characterization of NF and NF composites (SEM,WAXS)
- WEB activities

8. USKIM:

- Design of construction panels using ECO-PCCM materials in combination with other commercial construction materials
- Thermal and acoustic characterization of the obtained materials

9. MOEPP:

- Calculations of eco-indicators of the produced ECO-PCCM materials and comparison with reference data of commercial construction composite materials
- Suggestions for the correction of national standards and legislation required

10. STUDIO R:

- Design of construction panels using ECO-PCCM materials in combination with other commercial construction materials

11. IP-BAS:

- Measurement of L.O.I. of the composites and elemental analysis
- WAXS analysis

12. GEONARDO:

- Calculations of eco-indicators of the produced ECO-PCCM materials and comparison with reference data of commercial construction composite materials

Next meeting in Budapest, 29-30 March 2007

5^{th} MEETING - AGENDA

(4-5 September 2006, Argentona, Spain)

04/09/06 AFTERNOON SESSION (starting time: 15:00)

Presentation by	**Agenda item**	**Remark**	**Typical time**
MONDIRECT representative	Welcome		10 min
Coordinator Maurizio Avella	Presentation	II year report, remarks and notes	15 min
TMF Gordana Bogoeva-Gaceva	Presentation	Innovations/Research Work/ ECO-PCCM future directions?	15 min
ICTP M.E. Errico, G. Gentile	Presentation	PHBV/kenaf and PLA/kenaf composites	15 min
TMF Anita Grozdanov	Presentation	Rice straw based composites, reuse and recycling facilitites	15 min
TMF Aleksandra Buzarovska	Presentation	Thermal stability of biodegradable polymer matrix	15 min
CIDEMCO Miriam Garcia	Presentation	Development and design of recycling-reuse facilities for transformation of solid plastic waste into polymer mortars for the low-cost building industry	15 min
EURKOMPOZIT Vineta Srebrenkoska	Presentation	Development and design of recycling-reuse facilities	15 min

Coffee break (starting time 16:45)

Presentation by	**Agenda item**	**Remark**	**Typical time**
IP-BAS Emanuel Nedkov	Presentation	Characterization of NF and NF composites	10 min
Coordinator Dr. Maurizio Avella	Presentation	II year report, remarks and notes	15 min
ICTM Aleksandar Dekanski	Presentation	WEB activities	15 min
STUDIO R Sanja Radjenovic	Presentation	Design of interior partitioning panels, Report on the methods for the assessment and optimization of housing comfort	15 min
USKIM Zlatan Manov	Presentation	Characterization of the Composite Materials	10 min
GEONARDO Attila Uderszky	Presentation	Methods for the assessment and the optimisation of housing comfort	15 min

SOCIAL DINNER (starting time 19:30)

05/09/06 MORNING SESSION (starting time: 10:00)

Presentation by	**Agenda item**	**Remark**	**Typical time**
TMF Anita Grozdanov	Presentation	Dissemination of the project results	15 min
Coordinator Dr. Maurizio Avella	Presentation	II year report, Project tasks, fixing of the next meeting	15 min
Project Partners	Conclusion	Time table, Results discussion, Conclusions	60 min
Project Partners	Discussion	Discussion about financial reports	30 min

LUNCH TIME (Starting time: 12.30)

VISIT OF MONDIRECT

CLOSURE OF THE MEETING

PRESENCES AT THE 5th MEETING

	NAME	INSTITUTION	SIGNATURE
1	Anita GROZDANOV	TMF	
2	Javier BUSQUES	MONDIRECT	
3	Marta LOPEZ	MONDIRECT	
4	Miriam GARCIA	CIDEMCO	
5	Vineta SREBRENKOSKA	KOMPOZITNA OPREMA	
6	Dime DIMESKI	KOMPOZITNA OPREMA	
7	Ilo Markusoski	KOMPOZITNA OPREMA	
5	Maurizio AVELLA	ICTP	
6	Gennaro GENTILE	ICTP	
7	Attila UDERSZKI	GEONARDO	
8	Emanuel NEDKOV	IPBAS	
9	Zlatan MANOV	USKIM	
9	Aleksandar DEKANSKI	ICTM	
10	Valerio ZUCCHINI	KEFI	
11	Nenad RADJENOVIC	STUDIO R	
12	Sanja RADJENOVIC	STUDIO R	
13	Gordana BOGOEVA-GACEVA	TMF	
14	Aleksandra BUZAROVSKA	TMF	

(Original available to the EC)

Minute of the 6th meeting (technical meeting)

(1st of February, 2007, Skopje, Macedonia)

On February, 1st, 2007 the Technical meeting of the European Project ECO-PCCM (ECO-HOUSES BASED ON ECO-FRIENDLY POLYMER COMPOSITE CONSTRICTION MATERIALS) - Contract n. INCO-CT-2004-509185 was hold at Hotel Karpos, in Skopje – Macedonia.

In the same time, the first ECO-PCCM Workshop titled 'Opportunities for application of sustainable resources in composite construction materials' was organized

Partner tasks for the next sixth months of WP3 and WP5

1. ICTP:

5.TMF:

- Development and design of recycling-reuse of composite components
- Development of polymer mortars based on solid plastic waste as a matrix

6.EUROKOMPOZIT:

- Industrial processing of composite panels with thermal and acoustic
insulation properties.

8.USKIM:

- Application of ECO-PCCM in combination with other commercial construction materials.
- Physico-mechanical, thermal and acoustic characterization of the obtained materials.

9. MOEPP:

- Methods for the assessment and the optimisation of housing comfort: natural light availbility, indoor quality, ventilation, odour nuisances, *etc.,*
- Methods and techniques for calculations of the ECO-indicators.

10.STUDIO R:

- Design of interior partitioning panels
- Report on the methods for the assessment and optimization of housing comfort

Next meeting in Budapest, 29-30 March 2007

Technical Meetings with Macedonian Partners

01.02.2007 – (13,00 h – 13,30 h) / Visit to MOEPP, Skopje

01.02.2007 – (14,00 h – 14,30 h) / Visit to ZUSKIM, Skopje

01.02.2007 – (15,00 h – 16,0 h) / Visit to STUDIO R, Skopje

02.02.2007 – (10,00 h – 13,0 h) / Visit to EUROKOMPOZIT, Prilep

Agenda of the Workshop I (01.02.2007)
"Opportunities for application of sustainable resources in composite construction materials"

1. TMF	**Gordana Bogoeva-Gaceva**	**Innovations/Commercialization/Research in ECO-PCCM**
2. ICTP	**Maurizio Avella**	**ECO-PCCM: objectives and impacts**
3. ICTP	**Gennaro Gentile**	**Problems-Solutions in ECO-PCCM products**
4. TMF	**Anita Grozdanov**	**Ecological aspects in ECO-PCCM products: reuse and recycling**
5. TMF	**Aleksandra Buzarovska**	**Utilization of agricultural resources in composite materials with biodegradable polymers**
6. USKIM	**Zlatan Manov**	**Comparative analysis of conventional construction materials and ECO-PCCM products**
7. KO	**Vineta Srebrenkoska**	**Fabrication of compression molded eco-composites: optimal process conditions**
8. MOEPP	**Teodora Obradovic**	**Sustainable products: EU ECO-labels**
9. Studio R	**Sanja Jovanovic**	**Design of interior partitioning panels from ECO-composites**

Figure 49: People attending to the workshop

Presences at the Workshop - I

УЧЕСТВО НА РАБОТИЛНИЦА
(participation on the workshop)

"МОЖНОСТИ ЗА ПРИМЕНА НА ОБНОВЛИВИ РЕСУРСИ ВО КОМПОЗИТНИ КОНСТРУКЦИОНИ МАТЕРИЈАЛИ"

"OPPORTUNITIES FOR APPLICATION OF SUSTAINABLE RESOURCES IN COMPOSITE CONSTRUCTION MATERIALS"

01.02.2007, хотел Карпош, Скопје (9.00 – 12.00 ч)

ИМЕ И ПРЕЗИМЕ NAME AND SURNAME	ИНСТИТУЦИЈА INSTITUTION	КОНТАКТ / CONTACT (тел/ е-маил)
[illegible]ниел Шегмановиќ	Дипл. - технолог	070/557-437 [illegible]@yahoo.com
Билјана Петрушевска	Дипл. технолог	071-258175
Билјана Манојловска	ТМФ	075-579020
Горан Дембоски	ТМФ	070 805 599
Лилјана Пениќ	АФ	070 716004
Емилија [illegible]	ТМФ	[illegible]@tmf.ukim.edu.mk
Јадранка В. Јулов	ТМФ	jadranka@tmf.ukim.edu.mk
[illegible]	Еуроюникон	
[illegible]	Еуроюникон	[illegible]@yahoo.com
Спиновска Гордана	ТМФ	070 378023
Николовски Никола	ТМФ	071/517-007
Гурески Илче	ТМФ	071/906-900
Игор Јорданов	ТМФ	jordanov@tmf.ukim.edu.mk
Коси Слободан	ТМФ	
Теохарова Марина	ф-ка за [illegible] Неготино	043-361-202 (071-641874)
[illegible]	МЖСПП	3066930/164
[illegible]	ТМФ - [illegible]	
[illegible] Милан	Дипл. хем. инж	070-226-132
Милосављевиќ Томица	Технолог-хем. инж.	071-584256
Бојаџиски Мирјана	Технолошко-мет. фак.	075 54 6206
[illegible]	[illegible]	071 225 162
[illegible] Ивана	[illegible]	070 [illegible]
Бојан Димовски	ТМФ	070 880-433
Сања Ратковиќ	Студио Р	070 56 90 86
Јулијана [illegible]	Мин. за обр. и наука	3118-022 [illegible]
Ненад Ратковиќ	Студио Р	
Радован Ратковиќ	Студио Р	
Теодора О. Грнчаровска	МЖСПП	070 383-060 / t.grncarovska@moepp.gov.mk

Presences at the Workshop - II

УЧЕСТВО НА РАБОТИЛНИЦА
(participation on the workshop)

"МОЖНОСТИ ЗА ПРИМЕНА НА ОБНОВЛИВИ РЕСУРСИ ВО КОМПОЗИТНИ КОНСТРУКЦИОНИ МАТЕРИЈАЛИ"

"OPPORTUNITIES FOR APPLICATION OF SUSTAINABLE RESOURCES IN COMPOSITE CONSTRUCTION MATERIALS"

01.02.2007, хотел Карпош, Скопје (9.00 – 12,00 ч)

ИМЕ И ПРЕЗИМЕ NAME AND SURNAME	ИНСТИТУЦИЈА INSTITUTION	КОНТАКТ / CONTACT (тел/ е-маил)
1 Србиновска Весна	дипл. тех. [illegible] / [illegible]	070 889997
2 [illegible]	ОХИС	070/407 411
3. [illegible]	Протект М	070/861-560
[illegible]	студент ТМФ	070/466-303
5 [illegible]	студент ТМФ	070/742-502
[illegible]	МНСПП	070 269-936
[illegible]		
[illegible]	дипл. тех.	070 713 843
[illegible]	МСРР	075 449 [illegible]
[illegible]	[illegible]	070 216 292
[illegible]	ДУТ	070 457 450
[illegible]	студент	
А. [illegible]	ТМФ	070385052
А. [illegible]	ТМФ	070690012
[illegible]	ТМФ	
[illegible]	ICTP-CNR - ITALY	+39-081-8625058
GENNARO GENTILE	ICTP-CNR , ITALY	+39-081-8675204

Minute of the 7th meeting

(29-30 March, 2007 Budapest - Hungary)

On March, 29-30, 2007 the 7th meeting of the European Project ECO-PCCM (ECO-HOUSES BASED ON ECO-FRIENDLY POLYMER COMPOSITE CONSTRICTION MATERIALS) - Contract n. INCO-CT-2004-509185 was hold in Budapest-Hungary.

CONCLUSIONS

Partner tasks for the last sixth months

1- All the partners should prepare 30th month report before 15 of April and send it to Italy.

2 – Related to D4 (MATERIAL, Panels with high thermal and acoustic insulation performances for housing comfort), Partner 6 (Kompozitna Oprema) should send one of each sample-plates (Keanf based and Rise straw based) in Italy.

3 – Revised D5 (REPORT, Report on methods for the assessment and the optimization of housing comfort) Partner 12 (Geonardo) should complete with included additional part of Studio R and send it to Italy.

4 - D6 (DEMONSTRATOR-Report on Process to produce biocomposites panellised components**)** and D7(Report on natural fibre composite products at low-production cost) should be prepared by the industrial partners of ECO-PCCM: Kompozitna Oprema, Mondirect and CIDEMCO.

5 – D8 (DEMONSTRATOR- Report on Methods for the transformation/conversion of solid-plastic waste used to build eco-houses) and D9 (REPORT-Report on reuse and recycling of materials used to build eco-houses) should be prepared by the partners 5, 6, 8 and 9.

6 – D10 (REPORT –management) should be prepared by the partner 1 and 5.

1.ICTP:

1. Preparation of the final reports and the deliverables.

2.CIDEMCO:

1. Contribution to the preparation of D6 and D7.

3. MONDIRECT:

1. Report on Set-up of the machinery that could be used for production of NFC, including cutting knifes for pellets.
2. Contribution to the preparation of D6 and D7

4. KEFI:

1. Contribution to the preparation of D8 and D9

5. TMF:

1. Preparation of the deliverables D8 and D9.

6. EUROKOMPOZIT:

1. Pressing of the composite panels for the final models of the ECO-PCCM project and delivering them to Studio R, up to 10 of May 2007.
2. Characterization of the mechanical properties of the samples for the final model.
3. Contribution to the preparation of D6 and D7

7. **ICTM:**

1. Characterization of polymer mortars (SEM) and kenaf final composites (WAXS).
2. Survey of the WEB activities.

8. USKIM:

1. Thermal and acoustic characterization of the obtained materials.
2. Characterization of the mechanical properties of the samples for the final model.

9. MOEPP:

1. Calculations of eco-indicators of the produced ECO-PCCM materials and comparison with reference data of commercial construction composite materials, and LCA of eco-composites.
2. Suggestions for the correction of national (MK) standards and legislation required.

10. STUDIO R:

1. Preparation of the model ECO-HOUSE.

2. Preparation of the wall-models and similar elements for Eco-houses based on ECO-PCCM materials.

11. IP-BAS:

1. Measurement of L.O.I. of the composites and elemental analysis.
2. WAXS analysis
3. Survey of the characterization/experiments performed in IP-BAS on ECO-PCCM materials in the course of the project.

12.GEONARDO:

1. Calculations of eco-indicators of the produced ECO-PCCM materials and comparison with reference data of commercial construction composite materials, and LCA of eco-composites.

Final meeting and workshop in Macedonia, 13-14 September 2007

AGENDA OF 7th Meeting

29/03/2007

MORNING SESSION (starting time: 11,00)

Presentation by	Agenda item	Remark	Typical time
Host Institute: Geonardo - Director	Welcome		10 min
Coordinator Dr. Maurizio Avella	Presentation	30th-month report, Audit - remarks and notes	30 min
TMF Anita Grozdanov	Presentation	Recycling-reuse facilities of ECO-PCCM composites and waste materials into polymer mortars for the low-cost building industry	15 min
EUROKOMPOZIT Vineta Srebrenkoska	Presentation	Processing of composite panels	10 min
USKIM-ZIMRANT Zlatan Manov	Presentation	Thermal and acoustic characterization of the obtained materials	10 min
CIDEMCO Miriam Garcia	Presentation	1. Preparation of the complete formulation polymer/fibers/additives for composite pellets 2. Development and design of recycling-reuse facilities for transformation of solid plastic waste into polymer mortars for the low-cost building industry	15 min
STUDIO R Sanja Radjenovic Jovanovic		Design of construction panels using ECO-PCCM materials in combination with other commercial construction materials 2. Report on the methods for the assessment and optimization of housing comfort	15 min

LUNCH (starting time 13:00)

AFTERNOON SESSION (starting time14:00)

Presentation by	Agenda item	Remark	Typical time
MOEPP Teodora Obraodovic Grncarovska	Presentation	Methods for the assessment and the optimisation of housing comfort: natural light availbility, indoor quality, ventilation, odour nuisances, *etc.* 1.Calculations of eco-indicators of the produced ECO-PCCM materials and comparison with reference data of commercial construction composite materials. 2. Suggestions for the correction of national standards and legislation required	15 min
GEONARDO Attila Uderszky	Presentation	Methods for the assessment and the optimisation of housing comfort: natural light availbility, indoor quality, ventilation, odour nuisances, *etc.*	15 min
TMF Anita Grozdanov	Presentation	Dissemination of the project results	10 min
Coordinator Dr. Maurizio Avella	Presentation	III Year - Final report, Project tasks, fixing of next meeting	10 min

SOCIAL DINNER (starting time 20:00)

PRESENCES AT THE 7th MEETING

	NAME	COMPANY	SIGNATURE
1	MAURIZIO AVELLA	ICTP-CNR	
2	Javier Burgues	MON DIRECT	
3	ALEKSANDAR DEKANSKI	ICTM	
4	NENAD RADJENOVIC	STUDIO R	
5	Sanja Radjenović Jovanović	STUDIO R	
7.	DIME DIMESKI	Eurokompozit	
8.	VINETA SREBRENKOSKA	EUROKOMPOZIT	
9.	MIRIAM GARCIA	CIDEMCO	
10	BUZAROVSKA ALEKSANDRA	TMF	
11	BOGOEVA GORŠEVA	TMF	
12.	ANITA GROZDANOV	TMF	
13.	ZLATAN MANOV	USKIM INSTITUT FOR TESTING MATERIALS AND DEVELOPMENT NEW MATERIALS „SKOPJE"	
14.	TEODORA O. GRNCAROVSKA	MoEPP	
15.	UDERSZKY ATTILA	GEONARDO	
16.	GENNARO GENTILE	ICTP-CNR	
17.	MARIO MALINCONICO	ICTP-CNR	

(Original available to the EC)

Minute of the 8th meeting

(13-15 September, 2007 Ohrid - Macedonia)

On September, 13-15, 2007 the 8th meeting of the European Project ECO-PCCM (ECO- HOUSES BASED ON ECO-FRIENDLY POLYMER COMPOSITE CONSTRICTION MATERIALS) - Contract n. INCO-CT-2004-509185 was hold in Ohrid-Macedonia.

CONCLUSIONS

Partner tasks for the last sixth months

1. All the partners should prepare 36^{th} month report before 15 of November and send it to Italy.
2. D6 (DEMONSTRATOR-Report on Process to produce biocomposites panellised components**)** and D7(Report on natural fibre composite products at low-production cost) should be prepared by the industrial partners of ECO-PCCM: Kompozitna Oprema, Mondirect and CIDEMCO.
3. D8 (DEMONSTRATOR- Report on Methods for the transformation/conversion of solid-plastic waste used to build eco-houses) and D9 (REPORT-Report on reuse and recycling of materials used to build eco-houses) should be prepared by the partners 5, 6, 8 and 9.
4. D10 (REPORT –management) should be prepared by the partner 1 and 5.
5. Form C for all the partners to be prepared only for the 3rd Years
6. Financial report for the 3rd Year of the project activity
7. Audit Certificate including all three years of the project

8th MEETING

AGENDA OF 14/09/2007

MORNING SESSION (starting time: 9:30)

Presentation by	Agenda item	Remark	Typical time
Coordinator Dr. Maurizio Avella	Presentation	III year report, Deliverables, remarks and notes	30 min
TMF Anita Grozdanov	Presentation	Disseminatioin activities	15 min
USKIM-ZIMRANT Zlatan Manov	Presentation	Thermal and acoustic analysis of ECO-PSSM panels	15 min
Project partners	Discussion	Discussion about results, creation of conclusion, financial-audit reports,	30min

Coffee break (starting time 11.00)

OFFICIAL FINAL PROJECT MEETING

Presentation by	Agenda item	Remark	Typical time
TMF Dr. Gordana Bogoeva-Gaceva	Wellcome	Project review	10 min
Coordinator Dr. Maurizio Avella	Presentation	Project review	10 min
USKIM Dr. Velimir Stojkovski Vice-rector	Addressed word	Project Impact	10 min
MOEPP Mr. Mile Jakimovski Director of Environment Agency	Addressed word	Project Impact	10 min
Ministry of Education and Science INCO-Office Mrs, Violeta Atanasovska	Addressed word	Project Impact	10 min
TMF Dr. Slobodan Bogoevski Vice dean of TMF	Addressed word	Project Impact	5 min
TMF Dr. Anita Grozdanov	Presentation	Project review	15min

VISIT OF OLD TOWN OHRID (13.30-16.00)

WORKSHOP (16.00 – 19.00)

AGENDA OF THE 2nd WORKSHOP

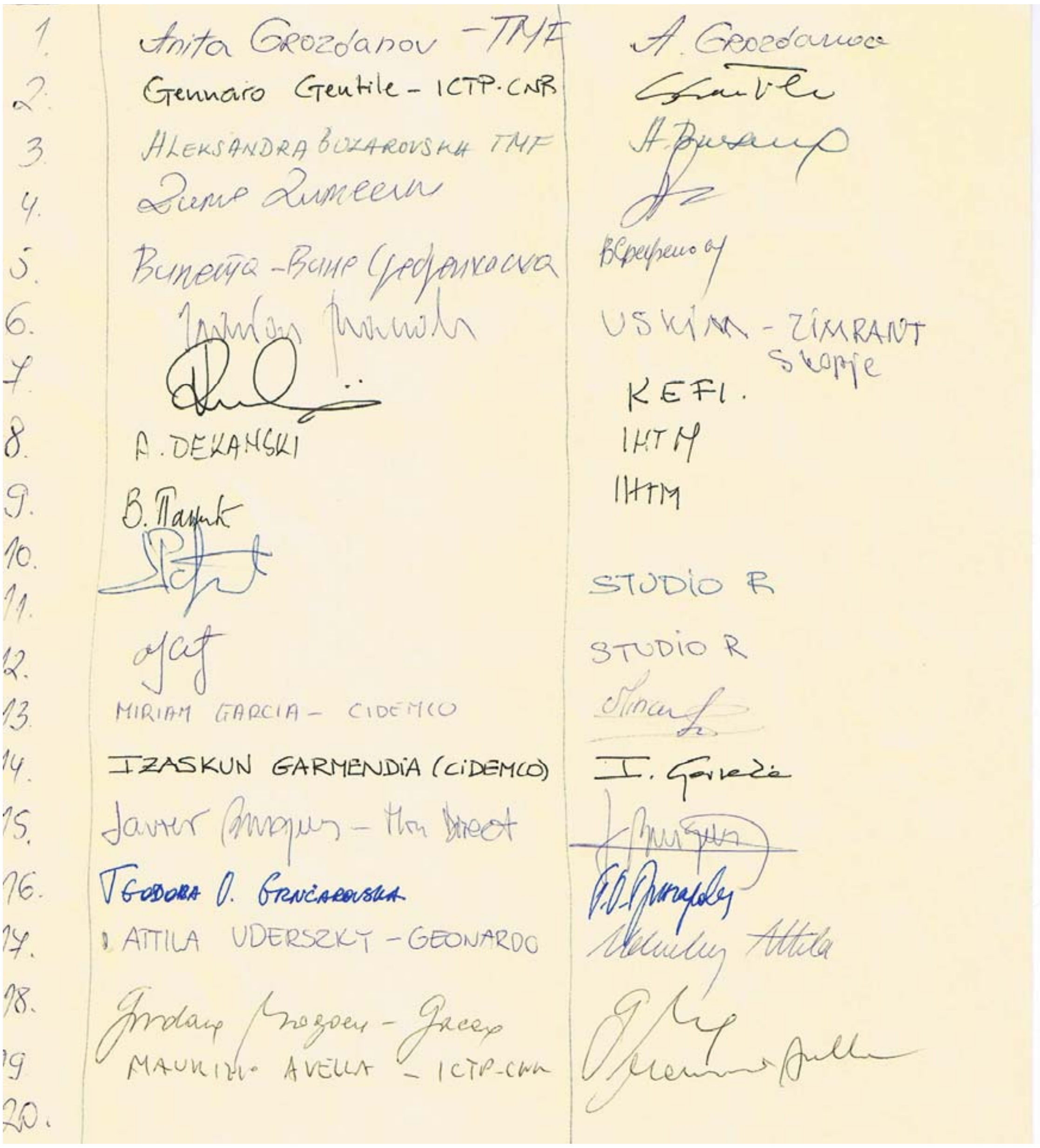
The concept of sustainable development in the field of materials: new materials and technologies based on renewable resources

M. Avella:	Sustainable polymeric materials and plastics
V. Zuccini:	The potential of Kenaf fiber for the production of eco-materials. Eco-products and eco-label
E. Milosevska:	Inorganics in sustainable products: experiences in Macedonia
A. Uderszky:	LCA approach and sustainable products
A. Buzarovska:	Utilization of agricultural resources in eco-products: experience coming from ECO-PCCM project
Z. Manov:	Construction materials based on renewable resources
G. Gentile: M.E.Errico	Creation of natural fibers/polymer composites: the problem of compatibilization
T. Obradovic:	Sustainable products and technologies: harmonization of MK with EU legislation
A. Grozdanov:	Ecological aspects of sustainable polymer composite materials: the potential of reuse and recycling
D. Dimeski, V. Srebrenkoska:	Conventional compression molding technique applied for manufacturing of eco-composites
Studio R:	Eco-house: new trends in architecture
G. Bogoeva-Gaceva:	Research, innovations and commercial eco-composite products
N.Markovska:	The role of new technologies in climate changes mitigation
V.Vukovic:	National Strategy for Sustainable Development of R.Macedonia

SOCIAL DINNER (starting time 21:00)

PRESENCES AT THE 8th MEETING

<u>Ohrid, 19/09/2007</u>



1.	Anita Grozdanov - TMF	A. Grozdanova
2.	Gennaro Gentile - ICTP.CNR	
3.	Aleksandra Bozarovska TMF	
4.		
5.		
6.		USKIM - ZIMRANT Skopje
7.		KEFI.
8.	A. DEKANSKI	IHTM
9.		IHTM
10.		
11.		STUDIO R
12.		STUDIO R
13.	MIRIAM GARCIA - CIDEMCO	
14.	IZASKUN GARMENDIA (CIDEMCO)	
15.		
16.	TEODORA O. GRNČAROVSKA	
17.	ATTILA UDERSZKY - GEONARDO	Uderszky Attila
18.		
19.	MAURIZIO AVELLA - ICTP-CNR	
20.		

(Original available to the EC)

Annex – Final plan for using and disseminating the knowledge

Section 1 - Exploitable knowledge and its use

After the publication of the web-site as the first step in the exploitation and dissemination activities, all the results have been continuously disseminated there. The ECO-PCCM website can be found at the following web address:

http://elchem.ihtm.bg.ac.yu/ECO-PCCM/.

The final goal of the website is the exchange of information among the partners and between the consortium and the society. Basic information on the project, contacts, links to news and websites related to the project, on-going activities and preliminary results are already available on the web-site.

The website is constantly updated during the lifetime of the project with all the scientific results obtained by the partners on the area restricted only for the project participants

Home page of ECO-PCCM web

Section 2 - Dissemination of knowledge

ECO-PCCM project activities include dissemination of knowledge and project results to a community as wide as possible. Sustainable development is one of the priorities of the scientific research work of FP6; therefore the results of the project will contribute to enable the Community to take advantage of the large economical and ecological benefits expected from the introduction of eco-friendly polymer construction composites in the product-service system of the sustainable tomorrow society.

Realised and planned dissemination activities for the IIInd year of the project are described in the following table.

During the 3rd year of the project, Dr. Anita Grozdanov (from partner no.5) has research stay two times in ICTP-Italy (partner no. 1). for preparation of the Periodic Activity Reports.

At the end of the project, ECO-PCCM brochure was prepared and published. It will be attached to the dissemination report.

Publishing and updating of the web-site of the project

The website of the project has been built-up and published at the web address http://elchem.ihtm.bg.ac.yu/ECO-PCCM/. The web-site has been continuously updated during the first year of the project, by publishing all the news about the project and all the preliminary scientific results. The web-site consists of many pages: some of them constitute the «restricted area», whose access is allowed only to the partners and to EC representatives. To have the access to this area, please use the following

Username and password: Username: ECFW6 Password: apidap

Congresses

1.Title: (Poster) ECO-HOUSES BASED ON ECO-FRIENDLY POLYMER COMPOSITE CONSTRUCTION MATERIALS

Authors: M. Avella, G. Gentile, M. E.Errico, G. Bogoeva-Gaceva, A.Grozdanov,

Congress: European Construction Technology Platform – ECTP Conference November 21-22, 2006, Versailles, France

2.Title: (Oral Presentation) INFLUENCE OF NATURL FIBRE TYPE IN ECO-COMPOSITES

Authors: Miriam García

Congress: 3rd Wood Fiber Polymer Composite Internationsl Symposium March 27-28, 2007, Bordeaux, France

3. Title: (Poster) RECYCLING AND REUSE OF ECOCOMPOSITES

Authors: Anita Grozdanov, Gordana Bogoeva-Gaceva, Maurizio Avella, AleksandraBuzarovska, Bojan Dimzoski, Maria E.Errico, Gennaro Gentile

Congress: IUPAC and ACS Conference on Macromolecules for a Safe, Sustainable and Healthy World,

June 10-13, 2007, Polytechnic University, Brooklyn, New York City, USA

4. Title: (Poster) AGRCULTURAL FILLERS IN BIODEGRADABLE POLYMERS

Authors: A.Buzarovska, G.Bogoeva-Gaceva, M.Avella, M.E. Errico, G.Gentile, A. Grozdanov

Congress: IUPAC and ACS Conference on Macromolecules for a Safe, Sustainable and Healthy World, June 10-13, 2007, Polytechnic University, Brooklyn, New York City, USA

5. Title: (Poster) SUSTAINABLE COMPOSITE MATERIALS BASED ON RENEWABLE RESOURCES

Authors: G.Bogoeva-Gaceva, A.Dekanski, Z.Manov,V.Srebrenkoska, A.Grozdanov, A.Buzarovska, M.Avella,

Congress: IUPAC and ACS Conference on Macromolecules for a Safe, Sustainable and Healthy World,

June 10-13, 2007, Polytechnic University, Brooklyn, New York City, USA

6. Title: (Poster) CRYSTALLIZATION BEHAVIOR OF POLYRPOPYLENE IN THE PRESENCE OF NATURAL FIBERS

Authors: A.Grozdanov, A.Buzarovska, G.Bogoeva-Gaceva,

Congress: EUROPEAN POLYMER CONGRESS 2007, EPF- 2007, July 2 – 6, 2007, Portoroz, Slovenia

Papers

– Published

1. Title: **Natural fiber eco-composites**

Authors: G. Bogoeva-Gaceva, M.Avella,M.Malinconico, A.Buzarovska, A.Grozdanov, M.E.Errico, G.Gentile

Journal: **Polymer Composites, Vol. 28, Iss. 1, Pages 98 – 107 (2007)**

2. Title: **Rice-straw as an alternative reinforcement in polypropylene composites**

Authors: A.Grozdanov, G. Bogoeva-Gaceva, A.Buzarovska, M.Avella, M.E.Errico, G.Gentile

Journal: **Agronomy for Sustainable Development,**
Vol. 26, Iss.4, Pages 251-255 (2007)

3. Title: N**onisothermal crystallization kinetics of kenaf fiber/polypropylene composites**

Authors: A.Grozdanov, A.Buzarovska, G. Bogoeva-Gaceva, M.Avella, M.E.Errico, G.Gentile

Journal: **Polymer Engineering and Science,**
Vol.47, Iss.5, Pages 745-749 (2007)

4. Title: **Poly(3-hydroxybutyrate-co-3-hydroxyvalerate)-Based Biocomposites Reonforced with Kenaf Fibers**

Authors: M.Avella, G. Bogoeva-Gaceva, A.Buzarovska, M.E.Errico, G.Gentile, A.Grozdanov

Journal: **Journal Applied Polymer Science,**
Vol.104, Iss.5, Pages 3192-3200 (2007)

5. Title: **Crystallization behavior of Poly(hydroxybytytrate-co-valerate) in model and bulk PHBV/kenaf fiber composites**

Authors: A.Buzarovska, G.Bogoeva-Gaceva, A.Grozdanov, M.Avella, G.Gentile, M.E.Errico

Journal: Journal of Material Science,

Vol. 42, Pages 6501-6509 (2007)

- Submitted for publication

1. Title: **KENAF FIBER SURFACE MODIFICATION: I. THERMAL STABILITY AND MORPHOLOGY**

Authors: A.Grozdanov, A. Buzarovska, G. Bogoeva-Gaceva, M.Avella, M.E.Errico, G.Gentile, A.Dekanski

Journal: **Composites P.A. (under review: JCOMA-07-248R1)**

Informations in public journals

1. Title: Successful story of investment in the technological development and the science in Macedonia

Journal: Journal of Engineering, 62, (2007)

2. Title: Construction eco-materials to become our reality

Journal: GATE, No. 66, page 2, 14.09.2007

3. Title: Scientific Project of EU: Macedonian Eco-house

Journal: TIME, No. 1182, page 2, 24.09.2007

4. Title: Successfully realized International project on Eco-houses

Journal: GATE, No. 67, page 3-4, 27.09.2007