European Cooperation in Science and Technology
- COST -

Secretariat

Brussels, 16 December 2010

COST 4202/10

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action FP1006: Bringing new functions to wood through surface modification

Delegations will find attached the Memorandum of Understanding for COST Action FP1006 as approved by the COST Committee of Senior Officials (CSO) at its 180th meeting on 1 December 2010.

MEMORANDUM OF UNDERSTANDING
For the implementation of a European Concerted Research Action designated as

COST Action FP1006
BRINGING NEW FUNCTIONS TO WOOD THROUGH SURFACE MODIFICATION

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4159/10 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to improve the scientific-based and public knowledge for enhanced surface modification of wood and wood products towards higher functionalization, the fulfilment of higher technical and environmental standards and a more innovative usage.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 52 million in 2010 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter V of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

Many applications of products are determined by their special surface properties, and based on the physical, chemical and biological interchange of various molecules with the materials surface. This is especially true for the use of wood and wood based products due to the special wood characteristics like anisotropy, UV-degradation. Thus, bringing new functions to wood through surface modification is needed in order to enhance the quality of the existing wood products and to open the way to new applications, products or markets.

This COST Action aims to provide the scientific-based framework and knowledge required for enhanced surface modification of wood and wood based products towards higher functionalization and towards fulfilment of higher technical, economic and environmental standards. This will be achieved by working within three main areas: Wood surface modification and functionalization, Wood interface modification and interface interaction and Process and Service life modelling.
Keywords: Wood and Wood Based Products, Wood Surface Modification, New Functionalities, Mechanisms for surface and interface modification, Interdisciplinarity, Environmentally friendly treatments, Service Life Modelling

B. BACKGROUND

B.1 General background

Wood is a sustainable source of material that throughout the history of human civilization provided important social, cultural and ecological values as long as a strong basis for the economic development of mankind. Through the years, wood has been at forefront of raw materials demanded by many industrial sectors, like construction, furniture, paper, and so on. This is because wood is a widely available material with unique properties like, mechanical strength, aesthetic appearance and thermal and sound insulation.

Although the desired wood properties and wide utilisation of wood as raw material in many industrial sectors, its use is compromised in some applications due to some draw-backs resulting from its variability both between and within species as well as its inherent physical-chemical properties (e.g. anisotropy, hygroscopicity). Wood performs variably in density, strength and durability, while it is susceptible to degradation by UV-light, chemicals, bacteria, fungi and insects when in humid environments. Moreover, wood lacks dimensional stability because of its property to swell and shrink when being in variable moisture conditions, caused by the large number of hydroxyl groups in the wood structure. Despite extensive research on wood modification processes, many methods still await implementations in the wood industry and some of them do not fulfil the potential of eco-friendly properties of wood. To stay competitive the wood industry has to innovate and develop new protective systems for wood and wood based products in order to improve durability and facilitate their maintenance and as well as to functionalize wood as to find new application and markets.

Surface modification is one of the most advanced scientific techniques that may lead to the goal of very precise applied surfaces and can enhance the overall profile of the surface specimens. Efforts have been made for investigation of surface modification of wooden surfaces using modelling and simulation techniques before the approaches were subjected to experimental trials. Also emerging techniques in the field of physics, chemistry, and computer sciences have an enormous potential for both the investigation of wood materials and development of new wood modification processes. The wood surface modification community has to get prepared for a continuous technological modernisation and for an efficient exploitation of the new possibilities. This requires close interlinking of various groups dealing with the different techniques and constant comparison of new results for verification. A COST Action is a perfect tool for this purpose. Moreover, innovation in the wood surface modification may also be achieved by combining different methods which are already well-established in the sector. Restriction on such approaches resulting from limited equipment and expertise available at single institutes' as well unnecessary duplication can be suitably overcome by this COST Action.

The innovative wood surface modification, the material behaviour analyses as well as the characterisation and process analyses will stimulate the development of new wood and wood-based products for the future. In order to make property changes, the chemistry of the components and the interaction between each other for the wood material must be understood. In the case of wood, the cell wall polymers (cellulose, polyose, and lignin) are the main components, which are modified to change the properties of the material. Following this understanding, the appropriate modification process will be devised to get the desired change in properties. In additional to the process, analysis (e. g. control, modelling) is important for a better understanding of the modification methods that may lead to process and design improvements. The basic variables and parameters of the relationships that describe the individual parts of the process must be worked out. Mathematical models help to describe the process and its application or enhancement.

Moreover, innovative approaches of surface modification will contribute to improved material properties and the process analyses. This will strengthen the confidence users (e.g. engineers and architects) and boost the use of wood also in conventional fields of application like façade and furniture. Together with the increasing demand for use of environmental friendly resources, the emerging technological possibilities bring about an enormous potential for future applications of wood. A profound understanding of surface modification processes is essential for being able to exploit this potential. This COST Action will contribute to establishing a suitable base for innovative surface modification techniques and knowledge for upcoming challenges of the forest product sector and enable the network of scientists from various countries and the free dissemination of information among them, resulting thus to the harmonization of the state of the art in the field throughout the EU countries.

B.2 Current state of knowledge

From a chemical point of view, the wood structure consists of cellulose, polyose and lignin, while the wood cells also contain at a lesser extent other components like tannins, resins, oil, fats, terpenes, flavanoids, quinines and alkanoids. The properties of wood surfaces are influenced by polymer morphology, extractive chemicals and processing parameters and conditions of end-uses. Wood modification is a means of altering the material to overcome or improve at least one of its disadvantages. The aim of a modification can be to bring an improvement in decay resistance,

dimensional stability, weathering performance, gluability, coatability, fireproofing, reduction in VOC emissions, and so on. Moreover, surface modification is one of the most advanced scientific techniques that may lead to most precise applied surfaces and can enhance the overall profile of the surface specimens. The broad range of possible wood and wood surface modification treatments is presented hereafter.

Bulking to fill the cavities in the cell wall as well as the cell lumen is a general approach. The treatments tent to reduce the swelling and shrinkage of the wood. Lumen filling with a substance, usually a resin can be an opportunity. These treatments might increase strength properties and slow down the process of water uptake. For example resins may fill the pores of wood thus providing a bulking effect that restrains the movement of wood or penetrate into its cell walls so bringing about a high degree of dimensional stability. The impregnation of wood with N-methylol compounds and especially dimethyloldihydroxy-ethylenurea (DMDHEU) followed by a curing step at high temperatures offers resistance against fungal attack and lessen shrinkage.

Altering the chemical structures of cell wall components (lignin, cellulose and polyose) and forming of covalent bonds. Modification in this sub-area can be divided into heat treatments, chemical modification and enzymatic treatments. Heat treatments for example have been found to provide wood durability improvement due to chemical modifications and degradations of the polymeric wood components and especially hemicelluloses that are a significant nourishing source for fungi. Applying the mentioned treatments some properties can be improved substantial, in particular durability, dimensional stability and reduced equilibrium moisture content.

Using different radiations to alter the wood surface properties (e.g. free surface energy, pH value, polymer adhesion ability). One example is plasma surface treatments. Wood activated by Diffuse Coplanar Surface Barrier Discharge (DCSBD) plasma results in the pH shifting to more acidic values increasing thus the free surface energy while reduction of water droplet uptake time is performed. Based on the gas used, the dielectric barrier discharge plasma treatment may increase the surface energy and chemical activity of wood resulting in hydrophobic surfaces. Plasma polymerisation treatment has also been applied to uncovered or covered wood performing improvement of its water resistance as to be suitable for external use. Another method is the microwave plasma (MWP). Radio Frequency (RF) capacitive or inductive charge at low and high pressures has also been used to modify wood surface energy affecting the contact angle and the polymer adhesion ability of wood.

Surface coatings of paint or varnish that are normally impervious to water. They are able to retard the swelling and shrinkage in short period changes of external conditions.

Other properties and functions of wood, like changes of wood colour when exposed to light and especially in the UV part of spectrum and anti-bacterial functions of some wood species.

Many modification methods were developed and in the last years, but many efforts have not led to an industrial application. The reasons are various like high production cost, crude modification techniques or reasonable alternative materials. However, due to further technological improvements there are promising areas for wood surface modification and functionalization like improved self-bonding, weathering and UV stability. Furthermore, the need to develop eco-friendly materials for future demands is steadily increasing. Also the methods of numerical simulations used for the analysis of temporal or spatial changes of phenomena (e. g. material properties) have further developed. Especially process analyses and prediction of service life time are recently in the main focus of known research institutes and associations. The complexity of the influencing factors can be very high due to the variety of the process parameters and the commonly used multiply components systems (e. g. wood and coatings) for the investigations. Sophisticated mathematical methods (e.g. stochastic methods) can be a promising approach. Moreover, the usage and development of computational modelling in many engineering disciplines were fulfilled during the last decades.

B.3 Reasons for the Action

The important role of forests in climate change has thrust forests and wood to the forefront of energy and climate policy. Forest products contribute to mitigating Climate Change by increasing carbon removals from the atmosphere. Their specific properties, such as carbon storage capacity, high recyclability, renewability of their raw material and the fact that they are less fossil-fuel intensive than other materials make them the material of choice to fight Climate Change. These facts have also put pressure on wood researchers and the woodworking industries. The demand for developing new treatments for eco-friendly products and for improving wood properties is greater than ever before in order to gain environmental benefits by making a wider use of wood-based products.

Surface modification methods have been used to overcome some of the drawbacks in wood utilisation and to improve wood properties like the ultraviolet stability of wood, the compatibility with coatings or the bonding between wood surfaces. Most of the processes require expensive equipment or reagents preventing a use of these technologies on a large scale. On one hand, new surface modification approaches, novel technological developments in this field and emerging experimental characterisation techniques will advance the current knowledge in wood surface modification. On the other hand there are challenges to be overcome e.g. in terms of long term improved performance and costs. Moreover, innovative material functions after surface modification and their process control require comprehensive knowledge of the chemical composition, material and surface microstructure and a good understanding of its behaviour.

To overcome these problems an interdisciplinary approach is needed. This COST Action will allow combining ideas, approaches, and trends from different areas such as surface chemistry, nanotechnology, biotechnology, mathematics, sensor technology and material science. It will also provide a platform for exploiting the new technical possibilities at the best and for identifying promising combinations of new and conventional surface modification techniques.

B.4 Complementarity with other research programmes

The Action will build on the achievements of existing and past European as well as international work in the field and will use synergies with current research activities. In this respect, the following already terminated and ongoing COST Actions are mentioned as relevant:

- COST Action E18 - High Performance in Wood Coating (1999-2004): The knowledge related to the interaction between wood and finish and the performance of exterior and interior finishes as well as the obtained achievements of the COST Action E18 in the field of sophisticated mathematical calculation models for prediction of service life and durability will provide a valuable input for this COST Action.
- COST Action E20 - Wood fibre cell wall structure (1999-2004): A great deal of knowledge on the wood chemistry and ultrastructure of wood fibre cell was achieved during this Action, which will be exploited in the new COST Action when the determination of the behaviour of the modified wood surfaces is concerned.

- COST Action E22 - Environmental optimization of wood protection (1999-2003): This COST Action will benefit from the achievements of the COST Action E22's State of the Art report on Heat treatments for wood through which the processing parameters critical for effective and optimum improvement in durability properties were defined. These achievements will be considered as reference work when heat treatment for surface modification will be applied.
- COST Action E37 - Sustainability through new technology for enhanced wood durability (2003-2008): The Actions development of systems for quality assurance and performance classification of modified wood and wood products are important and will be considered in this COST Action. Moreover, existing contacts between research groups established in the framework of this Action have already been and will further on be very helpful in developing and managing this Action.
- COST Action FP0904 - Thermo-Hydro-Mechanical Wood Behaviour and Processing (2009-2013): The COST Action will benefit from the results and achievements of this Action on wood mechanical and physical behaviour and its chemical degradation during Thermo-Hydro-Mechanical processing. These findings will be also important for the surface modification processes. An exchange of information will be ensured through the contacts involved in both Actions.

Possible links to Actions in other COST domains related to studies on the bringing of new functionalities to the surface of polymers in generally e.g. COST Action 868 – Biotechnical Functionalization of Renewable Polymeric Materials (2006-2010) of the COST Domain Food and Agriculture (FA) will also be considered. Moreover, this action will also benefit from scientific activities in ERA-NET WoodWisdom-Net projects in the Seventh Framework Programme (FP7), relevant for this Action:

- FibreSurf: New Biotechnical tools for wood fibre modification and analyses (2008-2011)
- WoodExter: Service life and performance of exterior wood above ground (2007-2010).

The participation of several experts of this Action in the WWN projects will guarantee active knowledge and data exchange.

C. OBJECTIVES AND BENEFITS

C.1 Main/primary objectives

The main objective of this COST Action is to provide the scientific-based framework and knowledge for enhanced surface modification of wood and wood products towards higher functionalization and towards fulfilment of higher technical, economic and environmental standards. Such improvement is essential for a wider and more innovative usage of wood and wood based products, also in the scope of tackling the climate changes, by lowering of usage of non-wood materials.

C.2 Secondary objectives

The secondary objectives of this COST Action can be summarized as following:

Improving knowledge

- Understanding of the relationships between wood and wood based panels surface and surface modification processes,
- Evaluating and understanding of the interactions between wood surface and modification methods and evaluating and understanding of wood interface modification methods and processes,
- Increasing the knowledge on the work going on in the field at the European level, as well on a world-wide basis, at both the laboratory and industrial levels.

Optimization

- Investigation of new wood and wood based panels surfacing methods to enhance existing properties and/or create new properties and/or new products,
- Enhancing existing surfacing and surface modification methods in light of their impact on properties, functionality and usability through a scientific-based research and development approach,

- Improvement of gluability, dimensional stability, durability, coatability, UV stability, fireproofing, tannin staining resistance, and machinability of wood and wood based panels through surface modification,
- Integrate fundamental research with applied science.

Long term performance evaluation

- to investigate adequate models for the description of the changes in material properties during the product life time,
- to evaluate the changes in material properties during the exposure time,
- development of adequate models for the description of the changes in material properties during the modification and due to modification.

Networking and exchange of information

- close collaboration and exchange of information between the scientific and industrial communities is crucial for the successful future of the wood surface modification processes,
- to improve the collaboration and exchange of information between interdisciplinary communities,
- to facilitate improved exchange of research results and data as well as providing a platform for young researchers for enhancing their research through the development of inter-European research networks.

C.3 How will the objectives be achieved?

The objectives of this Action will be achieved through an exchange of knowledge and ideas between young researchers, scientists and industry. The means to achieve the objectives are primarily:

- Bringing experts and young scientists from academia and industry from Europe and from other countries like Japan, New Zealand, USA together and spreading the knowledge. Such meetings will encourage the exchange of ideas and the presentation of recent and ongoing research activities in the individual countries as well as development of new ideas,

- Encouraging communication between scientists and industrialists from a broad background of research on surface modification of wood, to exchange their knowledge and their methodical knowhow,
- Integrating and applying relevant knowledge from other scientific sectors into the wood science community and future involvement of experts and additional partners from other disciplines (e.g. ceramic, coating, biotechnology, automotive) that join throughout the life of the Action,
- Coordination of joint research activities, ensuring the exchange of experiences and data. This will enable the use of best practice and minimizing the duplication of experiments and will also lead towards the creation of a common development program,
- Collaboration between academia and industry enabling the exchange of ideas and experiences
- Collaboration among different laboratories, exchange of experts and young researchers. This will enable them to familiarise with various characterisation techniques and encourage the collaboration between laboratories
- Improving the design of experiments and enhancing evaluation possibilities by combining experimental investigation with computer simulations for virtual testing. The cooperation and collection of data will enable the development of adequate models for the description of the changes in material properties during the product life time and during the modification.

C.4 Benefits of the Action

The action will contribute to the following areas:

Expected scientific benefits:

The exchange of information among scientists of different scientific fields will result in new ideas for methods and processes of wood functionalization that it is expected to result in new applications and markets for wood. Nanotechnology, plasma application, substitution of petrochemicals by other substances of natural origin that comply with the rules of green chemistry, as well as any other newly created knowledge from various scientific fields may hopefully contribute to the development of new products or methods.

Expected economic and technical benefits:

Technological advances and globalization are the two main factors that affect significantly the market. As many wood surface/interface treatment methods are already known and many others are under development due to the constant advances in technology, there is need for frequent update on the evaluation of the available methods and processes as to identify the optimum. The Action will evaluated cost effective and resource friendly processes and innovative application techniques. The technical benefits will be to offer the most efficient, easy applicable, profitable for the industry, environmentally friendly and socio-economically attractive treatment for each application of wood.

Furthermore, the better understanding of existing and the development of new wood surface modification methods and new material functionalities will expand the quality and properties of the existing wood products. This will open the way to new applications or markets. Examples in terms of new applications or markets are: Antibacterial functions and decontamination in medical environment or food contact, sensorial (e.g. optical) functions, barrier functions like fire resistance, electrical resistance, VOC barriers, self-healing functions, biodegradable or reversible adhesion. The benefits in that case will be an increased economic activity of the industry e.g. for the wood-based panel producers since any effective wood interface modification promotes the manufacturing of new panels.

Expected ecological and societal benefits:

With a view to the renewable material wood the surface modification method seeks to fulfil ecological perspectives (use of renewable ingredients), so that the wood products can hold their reputation as a natural material. By supporting a wider use of wood-based products through product improvement, further environmental benefits will be gained. Wood is a naturally renewable material growing in ever-increasing abundance in Europe. Forestry and wood products play a major role in combating climate changes and can help European countries to achieve their Kyoto targets, not only by increasing the carbon sink of wood-based products and growing forests, but also by decreasing carbon sources through substituting wood-based products for energy-intensive products.

C.5 Target groups/end users

The main target group of the Action is experts and researchers interested in surface modification and functionalization, modifications processes, process modelling and service live prediction from both academia and the industry. The Action is also of interest to young scientists and students of related fields (e.g. wood technology, surface chemistry, biotechnology) interested in improving their knowledge on the understanding of wood surface modification and interactions.

End-users are the wood industry and their customers looking for new material functionalities, new products and markets, new protective systems e.g. from decay and fire, improved durability, enhanced adhesion properties, increased dimensional stability, longer service life and easier maintenance of wood and its products. The work and findings of the Action might boost the use of wood also in conventional fields of application like façade and furniture.

As the Action seeks also to derive and combine ideas, approaches, and trends from different areas such as surface chemistry, mathematics, bio- and nanotechnology and material science, its innovations may also have applications in those domains and related industry sectors.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

This COST Action aims to apply promising techniques and methods in the fields of material sciences, nanotechnology, biotechnology, surface chemistry, wood physics and mathematics through the collaboration between groups from different disciplines, from academia and industry to overcome the major challenges of surface and interface modification of wood and wood based products towards higher functionalization. The major challenges of surface modification and functionalization are hereby described, with important research tasks to be coordinated by the Action outlined at the end of this part.

Understanding of methods, treatments and behaviour

In order to make property changes one must first understand the chemistry of the components and the contributions each play in the properties of the resource. Following this understanding, a way to modify what needs to be changed must then be defined to get the desired change in property. Properties of wood, such as dimensional instability, flammability, biodegradability, and degradation caused by acids, bases, and ultraviolet radiation, are all a result of chemical degradation reactions which can be prevented or, at least, slowed down if the cell wall chemistry is altered and modification processes are applied. This acquires a comprehensive knowledge of the mechanisms for surface modification of the wood and wood products and a good understanding of its behaviour for explaining the mode and mechanisms of action.

Meeting products needs

Altering the way in which wood is treated is known to dramatically change the way it performs. Thus, there is a need to better understand the methods needed, allowing treatments to meet product needs. Establishing a knowledge base for the mechanisms of surface modification of the wood and wood based products and a good understanding of its behaviour for explaining the mode and mechanisms of action will help in the basic understanding of the raw material, through detailed assessment of the complex interactions of wood components at the micro and macromolecular level. This understanding will help evaluate performance in use, the limitations of products and the overall service life of processed wood and wood products. In effect, these factors will help build up a quality control system for wood and wood products based around the modification and functionalization methods, thus meeting user needs for quality.

Providing industry with solutions

There is a need to better understand the methods needed, allowing treatments to meet product needs. Information about the various user needs and preferences will be collected. Based on these considerations development of new surface modification processes can be performed to fulfil the customer needs. It is intended to focus on and investigate possibilities of eco-friendly treatments. At the end of the Action, a troubleshooting handbook/manual with available solutions (classical and new) for each wood drawback along with the advantages and disadvantages of each solution will be available.

The COST Action scientific program encompasses a broad spectrum of research disciplines and competences. To ensure the achievement of the objectives, the work within this Action is divided into the three areas of scientific focus which are stated below:

a) Investigation of new surface modification and functionalization methods for wood and wood based products to enhance existing properties and/or create new properties and functionalities and/or new products.
b) evaluation of wood interface modification methods and processes and investigation of the interface interactions
c) investigation of adequate models for the description of the changes in material properties during the product life time

The scientific areas constitute the basis for the formation of Working Groups in this Action as specified below.

D.2 Scientific work plan methods and means

The work plan, equipments and methods required for achieving the objectives are hereby presented in relation to the three principal research areas outlined in section D.1. A more detailed work plan will be developed at the kick-off and the following meetings. Methods and instruments not included in the following section may also be included in the Action depending on availability and necessity.

Research area 1: ***Wood surface modification and functionalization***

In this area the scientific activities focus on new treatments to bring enhanced or new functionality on the wood surfaces. Many wood products are already available, but the possibilities of the forest are not exhausted and not well-exploited yet. It is possible to make even smarter products and to enter new fields of applications. Innovative product design and development requires comprehensive knowledge of the micro-mechanisms for surface modification of the specific materials and a good understanding of its behaviour for explaining the mode and mechanisms of action. Also information about the various user needs and preferences will be collected. Based on these considerations development of new surface modification processes can be performed to fulfil the customer needs. It is intended to focus and investigate possibilities of eco-friendly treatments.

In the last years, several wood modification technologies (e.g. acetylation, furfurylation, resin treatments etc.) were developed and introduced on practical scale. For a total modification of the entire wood dimensions, relatively high loadings and sophisticated technology is needed. In the case of the surface modification the properties of polymers are maintained and lower amounts of chemicals are needed for the modification process. Materials with a polymer substrate and functional groups on the surfaces play an important role for biomedical and chemical applications. A crucial condition for these materials is the possible linkage between the polymer substrate and the chemical reagents. Wood polymers show such functional molecule groups, and therefore wood could be a good polymer body for the modification step. Moreover, some wood species have natural bacteria resistance. Based on these considerations surface modification should be also possible on the wood materials. With a view to the renewable material wood the surface modification methods should also fulfil ecological perspectives, so that the wood products can hold the reputation as a natural material. Therefore, also surface modification methods using renewable ingredients and physical or chemical treatments (e. g. plasma treatment) will be considered.

The results might include new protective systems against abiotic and biotic degradation, as decay and fire, improved durability, improved UV stability, enhanced adhesion properties, increased dimensional stability and easier maintenance of wood and its products. Such properties are useful for many wood-based products like parquets, kitchen cabinets, furniture as well as panels for indoor and outdoor applications.

Research area 2: ***Wood interface modification and understanding of the wood – treatment interface interactions***

This area focuses on fundamental studies of wood interface modification which allows for example eco-friendly self-binding or wood to wood binding to occur. The focus will be set on studies of non-toxic interface modification methods for wood and wood products. Areas of interest will be e.g. the creation of bacterially generated adhesion, adhesion improvement by enzymatic pre-treatment, investigate wood interface modification in order to create adhesion or adhesion improvement, interface modification through friction, heat and pressure, coupling agents, investigate liquefied wood as a bonding or surface coating material or to improve the self-bonding properties e.g. joining of wood using linear friction welding processes.

In this Research Area also a comprehensive knowledge on the interface modifications mechanisms and interactions will be gained. Interface analysis will be carried out (ESR spectroscopy, NIR spectroscopy, 13C CP/MAS NMR,...) in order to get results on the effectiveness of the processes, long term performance, etc. The data will be used as input parameters and model validation for the Research Area 3.

The results might include enhanced adhesion properties for adhesives, paints, varnishes or the wood itself. Also increased surface density, dimensional stability and easier maintenance of wood and its products is possible. Products with these qualities will have importance in numerous applications. Such properties are useful for many wood-based products like parquets, kitchen cabinets, furniture as well as panels for indoor and outdoor applications.

Research area 3: ***Modelling of material behaviour and service life***

Understanding of the impact of different environmental conditions on the quality of material is essential for the prediction of products performance during its life cycle. Looking at different materials and modification methods the knowledge obtained by fundamental research and later used for the development of model will help to not only to simulate the changes in material properties but also in optimization of existing surface modification techniques and materials, development of new ones and also in saving time and money for the emerged modification methods. The developed models will also be a useful tool for the description of changes induced by the material itself but also due to the changes in climate and environmental conditions.

Particularly with regard to the developments of new surface modification processes, test methods for estimating material properties are necessary. For example, artificial weathering tests (e. g. light, moisture, temperature and acid) have a great potential for the evaluation of changes in material properties during the exposure time. The techniques of artificial weathering would be also support by the investigation of effects of natural weathering and changes in climate conditions on material properties. One of the parameters that will be described and covered in topic is also the assessment of the chemical and physical degradation factors of polymeric modified surface layers.

The existent dosage-response-functions of various materials (e. g. plastics) from other fields of research should be modified for the usage of the modified material properties. Also, an approach to use the probabilistic theory (e. g. Markov Chain) may have a great potential for the accurate modelling and simulation, provided that an adequate design of experiment is engineered.

The experimental validation of the model will contribute to its optimization. Moreover, the models will allow developing methods for computer simulations of the changes in material properties during the natural weathering, which are important for the estimation of the service life time of products. Due to the complexity of the interaction of the material and the environmental influences, a multi-disciplinary composition of the scientists (e. g. polymer science, environmental science, wood research) of this Cost Action is necessary.

Methods and instruments

The methods that will be employed for the surface modification, functionalization and interface modification in this Action are described as follows:

- *Chemical Modification Methods and Processes* like surface chemical modification for UV Stability or surface chemical modification for bonding e.g. the reaction of the wood surface with functionalized coupling agents to improve the compatibility to low-energy materials, activation of the surface using enzymatic means to generate surface free radicals or modification with UV-Stabilizers etc.
- *Physical modification methods* like corona or plasma discharge, dielectric barrier techniques, microwave-assisted surface modification, application of friction, heat and pressure and thermal treating of wood surfaces.
- *Enzymatic Modification Methods* like the use of enzymatic systems for surface activation of wood particles or to improve wood properties by laccase-mediated wood surface functionalization of enzymatically modified wood surfaces.
- *Interface modification* through friction, heat and pressure, the use of bacteria, coupling agents the use of bacteria, liquefied wood as a bonding or surface coating material. etc.

Further methods may be also included in the Action, depending on availability and necessity. Access will be also dependent upon participating members' facilities and equipments.

In order to fully ascertain chemical and physical properties of wood during and post-treatment, a wide range of methods and instruments will need to be used. Instruments and methods for determining meaningful data of the changes in material properties will be applied. This is to develop adequate models for the description of the changes and the simulation of the material properties. Access will be dependent upon participating members' facilities, but include the following:

- Suitable methods to study the untreated and treated wood surface like X-ray Photoelectron Spectroscopy (XPS), Ultraviolet Photoelectron Spectroscopy (UPS) and Metastable Induced Electron Spectroscopy (MIES) methods,
- Analytical instruments, such as Gas Phase Chromatography (GPC), Capillary Viscometer Analyzer (CVA), and Differential Scanning Calorimeter (DSC), X-Ray Diffraction (XRD).
- Micro-Analysis of the surfaces, interface, such as various forms of microscopy (atomic force, light, confocal, etc.),
- Mechanical testing, using all conventional methods, plus Digital Image Correlation and Optical measurement testing,
- Computational methods, stochastic methods, Scientific Computing (e.g. computer modelling and simulations techniques).

Working Groups

Three Working Groups will be formed according to the principal scientific areas described above:

WG 1: Wood surface modification and functionalization

WG 2: Wood interface modification and interface interactions

WG 3: Process and service life modelling

E. ORGANISATION

E.1 Coordination and organisation

The COST Action will be organized and coordinated by a Management Committee (MC) following the conventional structure defined in "Rules and Procedures for Implementing COST Actions" (COST doc. 270/07). The responsibility for the planning, execution, and documentation of the activities will be delegated by the MC to a Steering Committee (SC). The SC will comprise the Chair and Vice-Chair of the Action, the Leaders of the Working Groups, a nominated Website Manager, and when necessary others through appointment by the MC. In particular, the SC will be responsible for reporting to the COST Domain Committee, including the budgetary-control, planning and preparation of meetings and workshops, approval of Short-Term-Scientific Missions (STSMs) and Training Schools as well as the implementation of the dissemination activities. SC activities will be reported throughout the Action in the MC meetings and the SC will be bound to decisions made there. The MC will provide a platform for discussions about the scientific focus and the work programme of the Action. It will supervise and coordinate the research activities in the Action, draw up detailed plans, and track the progress in relation to the scheduled objectives.

The first MC meeting will be used for the initial planning and organisation of the Action, including SC composition as well as WG structure and composition. It will aim at the starting of efficient networking between participating labs, institutes and partners from the industry; help the Actions community to identify itself and its research areas, make the Action visible to the outer world, and also attract new parties to participate actively in the Action.

MC meetings will take place twice times to three times a year, generally in combination with SC meetings. The chairs of the WGs will have to present a consolidated report of their group to the MC. These reports will serve as the basis for monitoring and evaluating the achievements of the Action in particular in relation to the scheduled objectives. WG meetings will be organised at least annually for coordinating the research within the group and for stimulating scientific exchange. All representatives in the different WGs will be strongly encouraged to participate in these workshops for promoting an optimal exchange of knowledge and ideas.

Workshops will complement the WG meetings heading for fostering contacts and scientific exchange across the WG borders. Workshops will be held annually, possibly including both plenary sessions for all participants and parallel sessions for the individual WGs. Whenever possible, the SC or MC meetings will be organised in connection with WG meetings or workshops in order to minimise the costs for the coordination of the COST Action. On two occasions, the annual workshop will be extended into a public conference where the activities of leading academic and industrial fellows will be presented to a broader audience: after the duration of about two years to further advertise the new Action among scientist and industrialists within and outside Europe, and at the end of the 4-year period to disseminate the outcomes of the Action towards the international community, discuss follow-up activities and evaluate the achievements of the Action. The workshop in the first year will be the opening workshop of the Action. The workshops in the following years, although open to external participation, will mainly be dedicated to discussions about on-going research. During the workshop of year 2, there will be an internal evaluation of the Action and an assessment of the further research work necessary to successfully complete the Action. Possibly one workshop will be organized in connection with the European Conference on Wood Modification to publicise the Action to as many researchers and industrialists as possible.

Short Term Scientific Missions (STSMs) will be encouraged, especially among young scientists, as a means of furthering activities within the Action, with a minimum of 6 missions per each year granted. Evaluation of STSM applications will be via the SC and the chair will be responsible for the final approval, based on a continual application system. Furthermore, Training Schools will be held to provide information and understanding of methods, instruments, and applications. Held annually, these will be organised by a participating institution or laboratory (or combination thereof) based on a formal proposal to be evaluated and approved by the SC. Special attention will be paid to the requirements and the standard of knowledge of young researchers.

As a primary dissemination tool and communication tool between partners of the Action and other parties, a website will be set-up shortly after the first meeting. This website will allow the monitoring and presentation of the day-to-day activities of the COST Action as well as inform about upcoming events and meetings. The MC will elect a member of the SC to be responsible for the website management and maintenance (Website Manager).

E.2 Working Groups

As specified in Section D.2, three Working Groups will be established. For each WG a leader and a deputy will be elected at the first MC meeting for coordinating the work within the group and for representing the group in the SC. The participation of individual researchers in more than one WG will be possible and welcome for encouraging the information flow between the different groups. A close interlinking of the WGs will have highest importance for the MC and will be fostered by joint workshops and STSMs across different WGs. Through the close interlinking data for input parameters and model validation will be delivered from WG 1 and 2 to WG 3, while WG 3 will give input on the effectiveness of the processes, long term performance, etc. to WG 1 and 2. This will ensure a frequent update on the evaluation of the available methods and processes as to identify the optimum.

E.3 Liaison and interaction with other research programmes

The Action will interact with other consortia and international organisations active in the field of the Action to enable mutual exchange of knowledge and results, facilitated by STSM exchange and organisation of workshops. Examples of consortia include, but are not limited to, COST Action FP0904 (Thermo-Hydro-Mechanical Wood Behaviour and Processing), COST Action FP0802 (to increase the understanding of the modified wood surfaces microstructure and the numerical modelling of wood processing), Cost Action C25 (life cycle assessment process within the framework of sustainability), ERA-Net WinFur (Wood modification by furfurylation for window products, Wood-Wisdom Net 2007-2010) and the ERA-NET WoodWisdom-Net WoodExter (Service life and performance of exterior wood above ground). This project is about to end in February 2011, but established contacts with research groups of this project have already been very helpful in developing this Action and will be further pursued. Interaction will also be undertaken with the scientific committee of the European Conference of Wood Modification, next conference to be held in 2011, with regard to the potential industrial application of the research, contacts to wood modification companies and research groups in Europe.

The Action seeks also to derive and combine ideas, approaches, and trends from different areas such as surface chemistry and technology (e.g. chemical surface modification), mathematics (e. g. probabilistic theory) and material science. Thus, fostering existing and establishing new contacts with researchers of other disciplines and sectors will have highest priority in this Action.

The interactions will be in the responsibility of the SC by appointing liaisons, co-organizing conferences, joint events and meetings, and providing mutual information on planned events. In particular, coordination with other COST Actions will be a permanent item on the agenda for MC and SC meetings. The participation of several experts of this Action in the other mentioned Actions and projects facilitate the scientific exchange and joint activities.

E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. Emphasis will be given to the active participation of women in the work programme of the Action, in particular when deciding on WG composition and task coordination. Already the preparation of this proposal was strongly supported by female experts.

The Action will also be committed to considerably involve early-stage researchers. This item will also be placed as a standard item on all MC agendas. At least one early-stage researcher will actively participate in each WG. Furthermore, the involvement of early-stage researchers will be promoted in STSMs and active participation in Training Schools and Conferences.

F. TIMETABLE

The duration of the Action is four years and the proposed time schedule for the various activities is shown in the following chart. So far the meeting dates are indicative and may be changed depended upon discussions within the MC and SC. The early first meeting of year 1 will be the initial planning and steering seminar (MC and SC) followed by the second MC and SC meetings and the opening workshop (plenum). The first public conference and final conference will be preferably held in connection with established international conferences.

Timetable		Timeline																							
		year 1						year 2						year 3						year 4					
Management:	MC & SC Meetings		x		x		x		x		x		x		x		x		x		x		x		x
Event:	WG meetings				x				x		x				x		x				x		x		
	Workshops / Conferences				x						**x**						x								**x**
Exchange & Training:	STSMs	6-8 missions / year																							
	Training schools	1 school / year																							
Milestones:											1														2

The following operative milestones (MS), which are indicated in the chart, are scheduled:

- MS1: collection of first results completed, progress of the Action and achievements so far evaluated, review of the Action's activities and successes, deliverable: mid-term report *(M20)*;
- MS2: collection and review of results completed, final achievements of the Action evaluated; deliverable: final report *(M48)*.

Further important tasks will be:

Assessing of the most urgent knowledge gaps and research activities completed (M6)

Plans for new methods, interdisciplinary contacts defined (M12)

Continuously: Monitoring achievements by definition of Success Factors (companies involved) to align strategy with objectives early during the first meeting of year 1 (steering seminar)

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BA, CH, DE, EL, FI, FR, HR, IT, RS, SI, TR, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 52 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.
New Zealand has expressed its interest to participate to the Action.

H. DISSEMINATION PLAN

H.1 Who?

The main target audience for dissemination will be:

- the network partners,
- other researchers in the field (outside the COST Action),
- research institutes and academic units (in nearly related fields),
- other representatives of universities (outside the COST Action) teaching wood science or materials science or any relative, institutes offering courses relative to wood
- stakeholders from industry:
    - forest products industry,
    - equipment manufacturers,
    - furniture manufacturer,
    - building construction industry,
    - adhesive & sealants industry
    - paint, varnish, and lacquer industry
    - manufacturers and service providers in the field
- relevant European and national associations and confederations, e.g. the European Confederation of woodworking industries (CEI-Bois), the Confederation of European Forest Owners (CEPF), the Confederation of European Paper Industries (CEPI), the European State Forest Organizations (EUSTAFOR)

- European Platforms like the FTP (European Forest-Based Sector Technology Platform), and
- the general public.

Maintaining close contact with the relevant European and national associations and confederations (mainly CEI-Bois, FTP), and the use of their dissemination channels will further help to reach a broader audience.

H.2 What?

The SC will strive to set up effective dissemination mechanisms to publish the objectives and progress of the COST Action between participants, to the wider scientific community, to the public and other stakeholders. The MC will ensure the organization of WG meetings, workshops, and scientific conferences. The conferences will be an important place for disseminating the results and progress achieved to date to academic and industrial researchers. The conferences will also facilitate the intercommunication on the personal level between all the researchers coming from different communities, thereby enhancing the creativity and problem-solving ability of the participants. This intellectual collaboration can result in new developments key to furthering the objectives of the Action.

Other methods of dissemination will be promoted by the MC, including publications in peer-reviewed journals and presentations at international conferences and workshops. The MC will particularly support papers co-authored by various research groups at these conferences. Furthermore, the presentations of the workshops and conferences of the Action will be prepared and made available electronically on the Action's website. The publication of special issues of scientific journals as proceedings of Action meetings is envisaged to ensure the quality and originality of the research work as well as for well-informing about the Action. All publications arising from research carried out under this Action will credit COST support.

The most important dissemination tool will be the internet as it is very flexible and accessible to a large audience. The Website Manager will develop the website and ensure its maintenance, as well as continually update the site as information about events and meetings becomes available. The public domain of the website will include a ‘static’ section about the Action that covers:

- general information on the Action's programme and objectives,
- basic information on participating groups (contact person, available equipment, scientific focus and expertise, current and optionally completed research projects) with a link to the group’s website,
- information and forms to be used for STSM applications,
- information for scientists, industrialists willing to join the Action,
- and a ‘dynamic’ section with
- up-to-date timetables of the Action’s activities/events (planned workshops, conferences, etc.),
- program brochures of upcoming conferences, workshops,
- power point presentations given at meetings/workshops/conferences,
- information on recent scientific and technical achievements and related links,
- electronic reports of past activities and achievements,
- a troubleshooting handbook/manual with available solutions (classical and new) for each wood drawback along with the advantages and disadvantages of each solution.

Some of the sections envisaged within the dynamic section of the website will be within a password-protected domain to allow access to internal parties of the Action to post draft reports and publications. This system will also facilitate the rapid and efficient transfer of documents between researchers and other participants of the Action.

In order to enhance the reach and accessibility of the website, links will be established on selected websites (e.g. FTP) which relevant parties—such as researchers, industry stakeholders, and policy makers—would be anticipated to frequently visit.

H.3 How?

The Action's website serves as primary dissemination tool of the Action. It will contain information on the research agenda of the Action, activities, reports and publications. The website will be constantly kept up-to-date to inform the public about meetings, conferences, Training Schools, and past and upcoming events, not only within the COST Action but in related subjects. Particular care will be made by the Website Manager to ensure the accuracy and availability of the most current information on the website. Also after the completion of the Action, the website will remain open and the information available.

The scientific conferences will be of great importance to reach a broad audience and to increase the external visibility and publicity of the Action. Preferably they will be co-organized in connection with established international conferences like the European Conference of Wood Modification to be held in 2011. Contacts to the chair of the conference are already established through involvement in this Action. The MC will finalize the details regarding the activities and publications of the Action. A Dissemination Group will be nominated in the early phase of the initiative and held responsible for the development and maintenance of all methods of dissemination. In addition, activities and knowledge of this COST Action may be disseminated by posting relevant information on the websites of its industrial fellows to communicate dissemination activities to their clients.