Transforming urban and agricultural residues into high performance biomaterials for green construction

Reporting

Project Information

INNOBITE

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Closed project

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Periodic Report Summary 1 - INNOBITE (Transforming urban and agricultural residues into high performance biomaterials for green construction)

Project Context and Objectives:
Project context and expected impacts

Facing the need to move towards more sustainable patterns of consumption and production, new industrial processes need to be developed that result in significant steps towards the rational use of natural resources. Strongly supported by favourable policies and increasing social awareness, the global demand for biocompounds is growing and new sub-sectors such as Sustainable Construction are slowly getting consolidated in the market.

INNOBITE project (www.innobite.eu) has been built to have a direct impact on Europe 2020 Strategy priorities: two by-products of the European economy are being transformed into high-performing additives for construction applications through low energetic and strictly ecological technologies (EU Priority 1: 'Stable Growth')
Sustainable Growth based on cutting-edge knowledge (EU Priority 2="Smart Growth"), generating new job-intensive business opportunities for SMEs in the construction, chemistry, agriculture and forestry sectors (EU Priority 3="Inclusive Growth"). The knowledge developed within the project is thus expected to generate new business opportunities for existing industries in the construction sector, allowing them to diversify into new markets, but also to promote the creation of new companies, models and business areas.

Project strategy and objectives

Funded with €3.2M by the EC under the 2012 FP7 Environmental call, INNOBITE project involves 9 selected partners from 6 different countries, including 3 major research institutions i.e. Tecnalia Research & Innovation (ES)-Coordinator-, VTT (FI) and EMPA (CH), and 6 SMEs: Compagnie Industrielle de la Matiere Vegetale (FR), Tecnaro (DE), Advance Composite Fibers (ES), Exergy (UK), Vertech-Grop (FR) and ECOPulp (FI). Combining Biorefinery, Nanotechnology, Computer Modelling and Sustainable Chemistry, this consortium is developing innovative processes that transform two abundant and undervalued European biobased wastes into high performing materials, while the final aim of reaching the market with the technologies developed. The project evolves along two ideas: (1) adding value to the inorganic fraction of wheat straw as a key factor to turn the whole Biorefinery process economically feasible, and (2) producing nanocellulose out of highly recycled paper, thus giving an extra life to what once lived as a tree, later served as wood and finally was transformed into paper. The two most abundant fractions of wheat straw, lignin and cellulose will become, respectively, polymeric matrix and reinforcing material, allowing maximum efficiency of such resource.

Project Results:
The Scientific and Technological strategy that INNOBITE project is deploying over the 36-month duration involves working at different levels. Such a multilevel approach particulates the development of new commercial solutions in the different steps represented in the table below.
The first level works on extracting valuable compounds from the bio-based residues through biorefinery or low-energetic processes. The two natural residues, i.e. wheat straw and recovered paper, serve as raw materials to obtain silica, lignin and cellulose fibres (from the former) and a modified cellulose pulp designed to be easily converted into microfibrillated cellulose (from the latter). In the second level, those valuable compounds are treated, either chemically and/or mechanically, and transformed into useful additives that can be successfully incorporated into biocomposites formulations. The third level makes products out of those composites, adjusting the formulations first at lab scale and then at an industrial one, and validates them against technical requirements. Finally, the forth level evaluates the environmental credentials of the new products and works on their commercialization paths.

INNOBITE MULTILEVEL APPROACH
LEVEL 1. FROM RESIDUES TO VALUABLE COMPOUNDS
• Isolate silica, lignin and cellulose from wheat straw through a process integrated in an industrial Biorefinery
• Obtain a specialty cellulose pulp from recovered paper and wheat straw pulp, which is easily transformable into Microfibrillated cellulose

LEVEL 2. FROM VALUABLE COMPOUNDS TO COMPOSITE COMPONENTS
• Prepare silica-thermoplastic polymer masterbatches

LEVEL 3. FROM COMPOSITE COMPONENTS TO PRODUCTS
• Produce nanocellulose out of highly recycled paper
• Produce MFC and MFC films out of recovered paper
• Chemically modify cellulose fibres to improve compatibility
• Formulate lignin-based thermoplastic and thermosetting resins

LEVEL 3. FROM COMPONENTS TO PRODUCTS
• Process novel composites based on previous components
• Up-scale and technically validate processes and products

LEVEL 4. EVALUATING THE PRODUCTS
• Analyse environmental credentials of the product and technologies developed (including biodegradability tests, LCA, LCC and ETV)
• Analyse possible business models for the products and launch effective strategies

As for the first reporting period (corresponding to the first 18 months of the project), the work performed has almost totally covered Levels 1 and 2, while Levels 3 and 4 have already been launched. In more detail, three major components of wheat straw have been extracted at high purity through a biorefinery process; remarkably, INNOBITE has successfully developed and integrated within the existing process a new industrial step for the extraction of silica, something that had never done before. This highly sustainable new protocol, which will be subject to the Environmental Technology Verification in the second part of the project, is being considered for patenting by the partners involved in the development. Lignin, also coming from the wheat straw, has been used to formulate both thermoplastic and thermosetting polymeric matrices that are subsequently being used to prepare new biopolymers. One of these new lignin-based matrices, the thermoplastic one, has also resulted in a highly interesting new product as it improves certain characteristics of the reference material. Knowledge protection is also being considered. A third exciting result has come from the MFC films prepared from the specialty pulp prepared out of recovered paper. The combination of low energy consumption during MFC preparation and excellent mechanical performance of the films has brought lots of interest towards the MFC film-reinforced compartmentalization panels that are being developed.

Regardless these three major results, the rest of the project tasks related to period one have been performed as planned. Some difficulties which arose have been solved during very fruitful meetings where partners showed true commitment and involvement with INNOBITE project. Also, a considerable dissemination has already been carried out, including two major Workshops organized, one scientific paper published in an international journal and preliminary results showed at several international conferences. At month 15, the project was actually pre-selected candidate of the prestigious Green-Tec Awards, a German event which enjoys huge media coverage; unfortunately INNOBITE could not make it to the final round. By the launching of the project, it was envisaged the generation of as many as 10 assets, mainly involving production processes, new chemical modification routes and new bionanocomposite formulations. Out of them, 2 have already been achieved: (1) silica production integrated within an industrial biorefinery process and (2) industrial production of wheat straw lignin-based thermoplastic biopolymer. Others will surely follow, as INNOBITE is only at month 19 of 36.

Potential Impact:
The ultimate objectives of the project are:
- To develop and integrate in an overall biorefinery process an environmentally acceptable method for the production of silica
- To develop and commercialize lignin-based thermoplastic and thermosetting resins
- To develop and commercialize MFC films prepared from recovered paper
- To develop and validate novel composites based on previous components
- To analyse environmental credentials of the products and technologies developed
- To analyse possible business models for the products and launch effective strategies
extraction of the inorganic fraction of wheat straw

- To develop a method for the production of microfibrillated cellulose (MFC) out of recycled paper that balances the environmental impact of the recycling stage and the energy required for MFC production
- To obtain a nanocomposite made of lignin-based thermosetting resin and MFC which meets indoor walls specifications using less resin than current non-biobased systems, and is at least 50wt% bio-based
- To obtain a composite made of lignin-based thermoplastic resin and at least one of the following: silica, MFC and cellulose fibres, which meets technical specifications for decking or fencing, is >95wt% of bio-based origin and/or biodegradable and overcomes commercial WPC solutions by >10% on surface hardness, water-absorbency and/or durability, and
- To reach the market with all the technologies and products developed by the end of the project

These results will allow surpassing current limitations in various fields and at various production levels: usage of raw materials (boosting resource efficiency), sustainability of high-performance additives (avoiding oil-based and energy-intensive technologies), bioplastics performance (developing novel solutions) and environmental impact of existing construction materials (reducing drastically the carbon footprint).

The new biocomposite materials will be validated by designing and developing dividing panels for compartmentalisation and profiles for decking and fencing. These construction products will be evaluated against appropriate resistance and durability standard tests to guarantee complying with minimum technical standard and endorsing their launching into the market. They will be also subjected to biodegradability trials, aiming to highlight the environmental benefits over current solutions. Both the products and the production processes developed will be evaluated, respectively, with Life Cycle Analysis and EU-promoted Environmental Technology Verification, the most rigorous environmental controls that exist.

List of Websites:

www.innobite.eu

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