Laymans report – Fiber composite

Introduction

Toxic chemicals, fossil raw material and bio-accumulative substances are some of the problems in many materials. OrganoClick, a Swedish material and chemical technology company founded as a University spin-off in 2006 based on research in green fiber chemistry is working with developing environmentally friendly fiber based materials using green chemistry. The company's proprietary technology for modification of bio-fibers is used to make materials water repellent, fire resistant and mechanically stronger. Many traditionally used problematic chemicals can thus be replaced with green alternatives.

In the production of particle board, high amounts of formaldehyde based glue is used which is carcenogenic. By using a new technology for molding fibers in combination with OrganoClick's material technologies, a lightweight material has been developed that may substitute particle boards in many applications. In particular in products requiring 3-D shape as the molding technology enables large 3-D shaped objects to be produced in a simple an automated way.

In this project, a first product in form of an eco-coffin has been developed using this new material and molding technology. A majority of funeral coffins are currently made of particle board and is rather labor intensive to build. By using the new molding technology a more automated production can be achieved, saving both cost and the environment. This project has focused on setting up a first production plant for producing the new material and launching the funeral coffin on the Nordic market.

Funeral coffins

Naturally the funeral industry is a global business with a global market. However the industry is driven by traditions that vary between cultures and countries affecting the market for coffin manufacturers. A growing trend in many western countries is so called eco-burials. This is in particular common in Anglo-Saxon countries such as the US and Great Britain. In these countries many funeral homes offer green burials in which the whole funeral is performed in a sustainable way, including coffins, urns and how the ceremony is performed. Many consumers are today also willing to pay a premium for a green funeral.

The "green" coffins currently on offer uses exclusive materials such as solid wood. These materials are in most cases sustainable but are also very expensive in comparison with particle board. Materials that are common are for example pine and oak. These coffins are often made by hand and are also often tailor made for the customer.

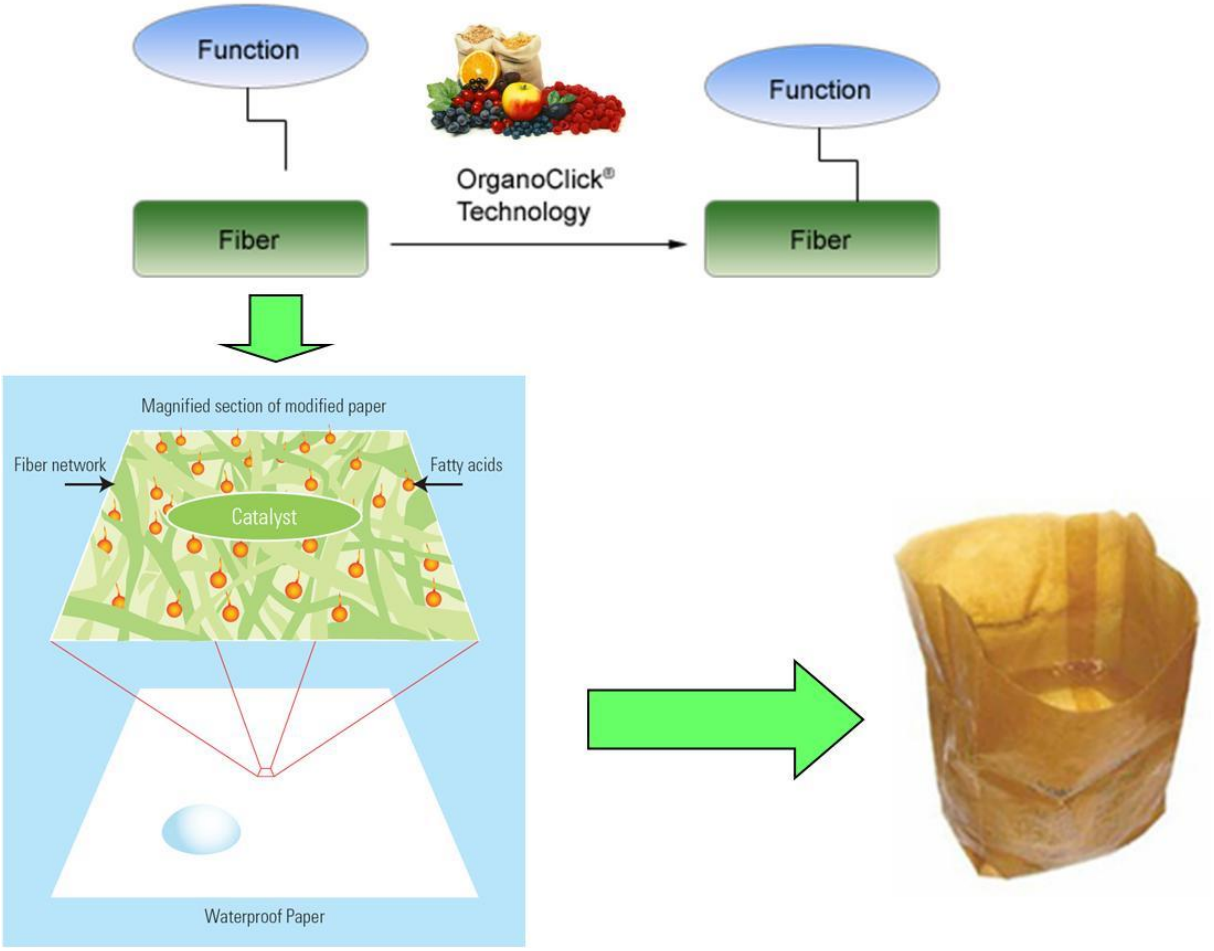
In total, approximately ~5 million coffins per year are used in Europe each year. As environmental awareness increases, it is projected that the interest in eco-burials and thus eco-coffins will increase. In principal, the market for eco-coffins is the same as the traditional market given that the eco-coffin provides the right quality and price.

An awarded solution based on biomimicry

Since the mid 90's, OrganoClicks two scientific co-founders, Professor Armando Córdova at Stockholm University and Associate Professor Jonas Hafrén at the Swedish University of Agricultural Sciences has performed research on fiber chemistry and wood-based materials. In particular, their

interest has been on how to modify the materials by using green chemistry in order to enhance or change the materials functionality.

In material chemistry, an emerging field is so called biomimicry in which naturally occurring processes and functions are studied and replicated in industrial applications. A specific chemical field of biomimicry is organocatalysis in which small naturally occurring organic molecules that catalyses chemical reactions are studied. In the new solution developed by OrganoClick, organocatalysis are used in order to change the properties of the fibers in wood, paper and textile fibers.



In 2006 OrganoClick was started as a spin-off from Stockholm University and the Swedish University for Agricultural Sciences. Since then, several new materials has been developed based on the company's technologies and know-how. Examples are the durable and fire resistant wooden material OrganoWood®, the water repellent textile OrganoTex®, and products to enhance the mechanical properties of paper and textiles. The company has been awarded with many prices for its green solutions, including being recognized as a "Climate Solver" by the World Wildlife Fund – the WWF, being selected as Sweden's best environmental innovation of the year and being elected to the prestigious list Sustainia 100 as one of the 100 most sustainable innovations in 2015. The company has grown from its start and currently has its operations, production, R&D and headquarter in Täby, north of Stockholm and employs 25 people.

Why funeral coffins

In 2009, OrganoClick was given the question if it could develop an environmentally friendly material for a funeral coffin. The material needed to be strong, burn in a controlled manner and be water resistant. It also needed to have a price which was within the same range as particle board which is the predominant material in coffins but which also contain formaldehyde based glue.

At the same time, OrganoClick was involved in a project to mold small paper products for packaging solutions. The thought came if it was possible to make large containers, such as a coffin, with a similar technology which would both increase productivity and create an environmentally friendly material.

The question was in the air and a pre-study was performed in 2009 with the financial aid of Vinnova – the Swedish innovation agency. The pre-study showed that it was indeed possible but that there were several challenges that needed to be solved. In particular, there did not exist any molding machines that could produce such big products with high quality. Therefore, in parallel with the new material, also new production technology needed to be developed.

A more in-depth development project was performed during 2010, also supported by Vinnova, in which a prototype material and a lay-out of the molding machine was developed together with an engineering firm specialized in molded pulp. A prototype material with the required properties was developed and tested and a lay-out of the machine was produced.

Except for the development of the material and a lay-out of the machinery, the development project also showed that the new material could be made much lighter than current materials. A traditional coffin made from particle board weigh approximately 35 kg while the weight of the new eco-coffin could potentially be reduced to 10 kg. This would in addition to replacing the glue also save a lot of raw material in the production of the coffin. The raw material could also be based on recycled fibres, creating an even better environmental product. In summary, the increased productivity, the reduction of raw material and chemicals and the use of recycled fibres opened up for creating a superior product in an economical way.

The consortium

After the development project the next step was to build and set up a full scale pilot machine in which the molded material could be produced. Several coffin manufacturers was contacted and the idea was presented. The Nordics largest coffin manufacturer, Nyarp got interested and discussions about a collaboration started.

Together with Nyarp, an application for funds from the EU-program Eco-innovation was made for a project to construct, build and set up a pilot production machine for making the molded fiber composite materials and thereafter launch the product in the Nordics and selected European countries. The application was granted in 2012 and the project started in August 2012 with the aim of having launched the eco-coffin on the selected markets within a 3 year period.

The objective and goal of the project

Since the start of the pre-study in 2009, the objective has been to produce an eco-coffin to an affordable price. As current eco-coffins are priced in the premium segment they only appeal to a certain customer segment. We truly believe that many more people would chose an environmentally friendly solution if there are products that have similar prices as current products.

The goals with the project was set and specified together with Nyarp and included both environmental and economical targets as summarized below:

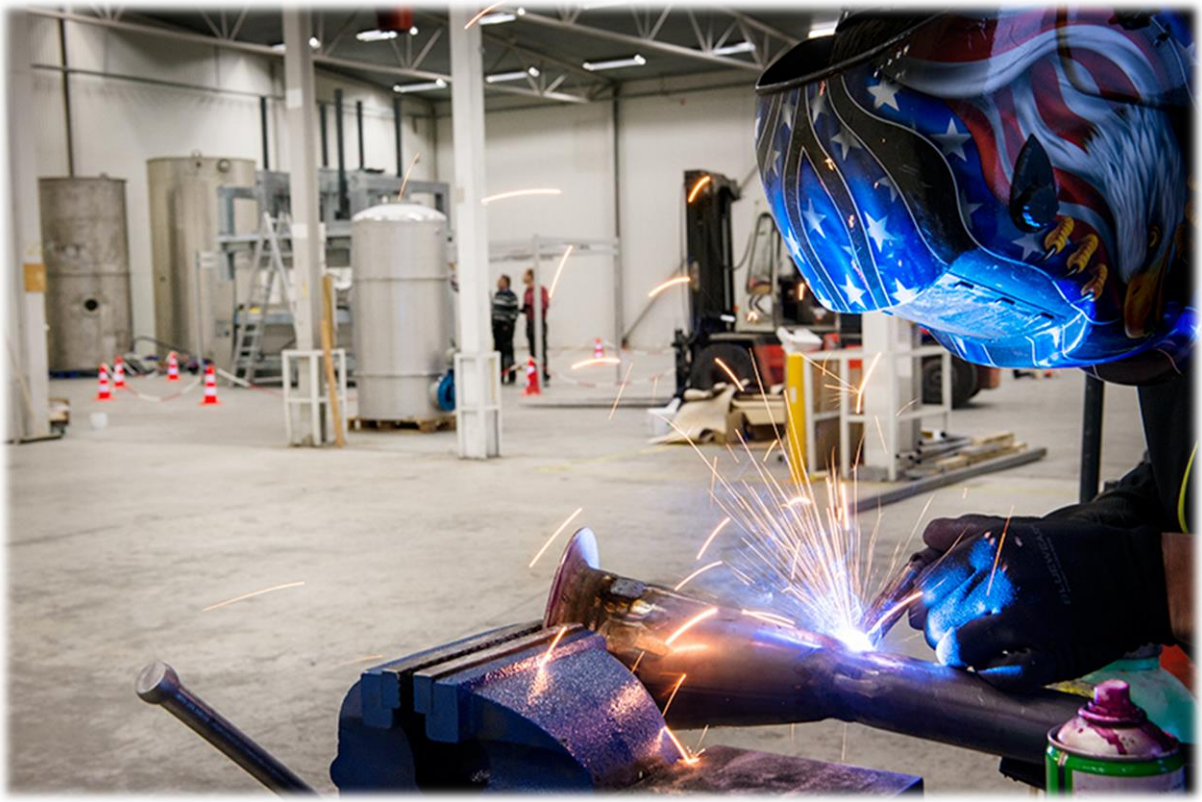
- Reduction of raw materials with more than 50 % / coffin
- Elimination of 4-6 kg of formaldehyde based glue / coffin
- Production cost at or below the current particle board based coffin
- Market introduction in the Nordic countries as well as in some other selected European markets

Actions

The project financed by the European Commission had a duration of three years. During this time, a production machinery would be constructed and set up and the coffin would be market launched in the Nordics and in some selected European markets. In order to enable this, a number of activities and actions had to be performed including building a new factory as well as marketing activities.

Activity 1 - setting up the production machinery

The first step of the project was to construct and set up the production machine for molding large fiber based objects. This was one of the major challenges as it did not exist any similar machine before and there are many parameters to take into account when developing and designing new production technology. Sub-contractors were engaged and the construction work started. It took nearly two years to have the machine in place but in September 2014, the machine was finally installed and the molds arrived somewhat later.



Activity 2 - testing the product

A funeral coffin does not sound like a high-tech product, rather one would think that the design and feel of the product are the only important parameters. However, the technical specifications for coffins makes them also very interesting for a material chemist. According to Northern European standards a coffin must:

- Be able to carry a weight of a 120 kg body
- Be able to be transferred in and out of a freezer and thus withstand different degrees of moisture
- Not catch fire in an 800 – 1 000 °C oven for 15 seconds and thereafter burn in a controlled manner in order for the cremation to be efficient

During the first year of the project, in parallel with constructing the production machinery, several prototype coffins were produced manually and tested. Tests were performed of the mechanical strength as well as the water repellence and moisture resistance of the coffin. The most interesting test was however the full scale cremation tests. At a crematorium in Sweden, several cremations of prototype coffins were performed in order to test the coffins combustion and to optimize the material accordingly. When these tests were completed, the material composition could be finally decided and set.

Activity 3 – market introduction of the new product

Even before we had the production completely in place we started with promotional activities on the Nordic market. Consortium member Nyarp is the dominating coffin producer in Scandinavia and thus have an extensive customer network built up over decades. Several of their customers were introduced to the project early and even had a say about the final design of the coffin as to assure that the product would have a good welcome on the market. The design was chosen from one of Nyarp's current models but slightly changed as the new production technology can incorporate new design elements easily.

A prototype coffin were produced manually in order to show it to the customers and gain early pre-orders of the product. This was performed successfully and in front of the market launch a number of funeral homes have signed up for being part of the introduction.

In parallel, distributors in some selected European countries have been contacted and discussions about collaborations have started. The goal is to sign distribution agreements with them shortly after the introduction in the Nordic market.

Activity 4 – optimization of the production

The production tests and optimization of the machinery took place during the spring 2015. Several small changes had to be done to the machine as well as the molds before the product was ready. As the product is based on a lightweight material, the construction of the material is also highly important.

Quality assurance with more tests were performed and as part of this OrganoClick also certified its quality and environmental management control system according to ISO 9001 and 14001.

Activity 5 – marketing of the product

As the product is based on a new, unique concept, marketing of the product is of outmost importance in order to get a good reception on the market. During the project, a small project website has been produced which will be transformed into a bigger product website once the product is market launched. In addition, promotional material in form of brochures are being produced during the project in order for the funeral homes to present to the end-customers. Marketing of the product to the funeral homes have been made by several mini-fairs organized by Nyarp in which funeral homes have been invited to see the new eco-coffin.

Activity 6 – exploitation of new markets

Except for being used as a material for eco-coffins, the new material and production technology have the potential to be used in many other applications. Part of this project was to exploit new applications and to make a plan on how to approach these areas. An area that early came up as an

alternative were furniture's such as lightweight table tops, chairs and benches. Other applications may be interior panels in automotive vehicles. Some of the areas has already been started to be explored even further and some collaborations have started.

Results

During the duration of the project a number of the goals have been reached. The major objective to set up and start production of the new molded material for coffins have been performed and coffins are now ready for a broader market launch. The final specifications and performance of the final coffin are now as follows:

- Weight of 12 kg saving 66 % raw material compared to traditional coffins
- Material with no formaldehyde containing glue
- Completely based on renewable material
- Biodegradable and compostable
- Can be produced using recycled fibers
- Competitive production cost
- Similar design as current coffin models

The coffin has also been introduced to funeral homes in the Nordic market as well as to potential distributors in selected European countries. All of them have shown great interest in the product and several have signed up for the introduction. The next step is now to widely roll out the product in a broader market launch. Our belief is that it will be a success as we have been able to set up a completely new and efficient production of a product with many benefits compared with current products.