Issue 1 January 2005

SustainPack :: Newsletter

Innovation and Sustainable Development in the Fibre Based Packaging Value

Welcome to SustainPack

Welcome to the first SustainPack Newsletter. Over the next four years, the SustainPack Newsletter will tell you about the activities and results of the biggest research project ever undertaken for paper and board-based (i.e. fibre-based) packaging. These newsletters will be published every 6 months, alternating between a bulletin and a "Plus" 32-page colour version.

The main objective of SustainPack is to ensure the future prominence and competitiveness of fibre-based packaging using the exciting new developments in the field of nanotechnology (see special feature). Through the development and application of nanotechnologies, SustainPack will reduce supply chain costs and add value by enhancing the functionality of fibre-based packaging. With a budget of €30 million over four years (€16.8million of which is being funded by the European Union's 6th Framework Research Programme), SustainPack brings together a large consortium of 35 of the best organisations, universities and companies in Europe working in paper and packaging disciplines.

By focusing on fibre-based packaging and other renewable resources, sustainability is a major theme of this project. The impact of packaging into consumers' everyday life, and its influence on ecology and the economy, makes packaging an important factor in our struggle to build a truly sustainable society. Micro and nanotechnology solutions which help us to meet the objectives of sustainability must therefore be embraced and fully utilised by fibre-based packaging.

SustainPack is a unique opportunity for everyone involved in the fibre-based packaging value chain – from suppliers and raw materials producers, through converters, fillers, brand owners and retailers – to define the future of packaging. We hope you will not only learn from this newsletter, but that you will also be able to participate in future SustainPack events, such as the technology mapping activities, market research, and the strategic conferences and seminars. We value your feedback and opinions, and will be shortly launching our website (www.sustainpack.com) to keep you more regularly updated on new developments and news.

We look forward to working with you throughout the project.

Kennert Johansson
SustainPack Co-ordinator
STFI-Packforsk

Contents

Diary

22nd - 23rd June 2005
Innovation Packaging Workshop, PTS, Germany

28th - 29th September 2005
SustainPack Strategic Conference, Pira, UK

For more information see www.sustainpack.com

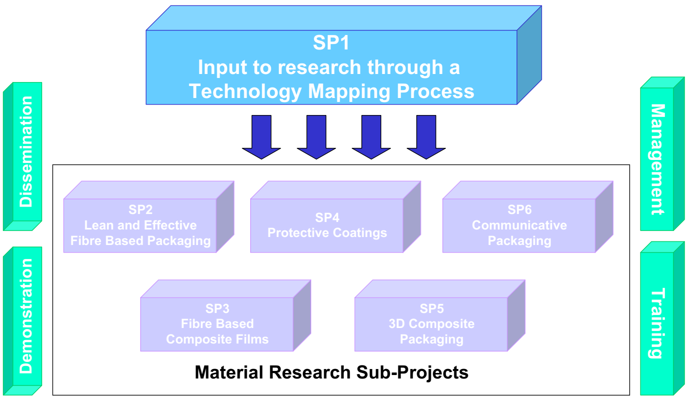
Project Overview

SustainPack focuses on customer and downstream supply chain needs and therefore is a "pull" driven project as opposed to a "push" one (i.e. technology-driven). A technology mapping approach (Sub-Project 1), which involves intense consultation with packing users, provides the context and motivation for each of the five applied technical research sub-projects, focusing on:

- Lean and effective fibre-based packaging
- Fibre-based composite films
- Protective coatings
- 3D composite packaging
- Communicative packaging

Each of these sub-projects is described in more detail in the following sections of the newsletter.

SustainPack sub-projects and activities



Demonstrator projects will be an essential part of SustainPack - after all, "seeing is believing". Demonstrators use available knowledge, transforming research results into proven technology. The objective is to prove the technical viability of a new technology together with its possible economic advantages under realistic conditions. Open calls for tender will be made at appropriate points in the project in order to bring in new partners (especially SME partners) offering the technical expertise and physical resources necessary to deliver the demonstrator projects.

Throughout the lifetime of SustainPack, there will be a number of dissemination events to publicise the project progress. As well as three strategic conferences, each sub-project will hold its own technical seminars. The first strategic conference is scheduled for September 2005. Dates for all events will be communicated through the newsletters, and through the project website, SustainPack.com.

Sub-Project 1 Update: Technology Mapping

An important characteristic of SUSTAINPACK is that it is a "pull driven" project. It focuses on the needs of customers and the downstream supply chain, including environmental and sustainability issues, thereby identifying research requirements and integrating other key themes. Sub-Project 1 provides this pull focus through Technology Mapping, this being a a critical component of its activities.

Sub-project 1 leader Michael Sturges

Technology mapping is a technique for identifying areas of technological promise and planning their development and implementation. This is achieved by a group of knowledgeable participants predicting the likely future and determining what needs to be done in order to get there. It is a process that provides structure and direction for developing and managing technology research and development (R&D). It allows the partners to anticipate, monitor and manage the risks associated with the fundamental R&D aspects of SUSTAINPACK.

The technology mapping process brings together the supply chain stakeholders in order to determine the trends and drivers that influence the packaging that we will use in the future. From these trends and drivers, the packaging features of the future are identified, and ultimately the technology developments and R&D required to deliver these future packaging features are plotted. The final result is a detailed critical path for each of the applied technical research sub-projects in SustainPack.

So far, Pira have facilitated four technology mapping workshops for Sustainpack, in UK, France, Slovakia and Copenhagen. Further sessions are scheduled for this year in Spain and Sweden. The workshops to date have focused on defining the trends and drivers, and defining the packaging features required in response to these. In the New Year, a further five workshops will be held (one per applied technical research project) concentrating on the technology requirements and R&D activities necessary to deliver these future packaging features. This process also helps the SustainPack consortium to identify and develop appropriate demonstrator projects by engaging with and creating interest among major packaging users, such as brand owners and retailers. The technology mapping activities are also being supported by a number of other strategic research activities, such as market interviews with nanotechnology providers, consumer interviews, and supply chain workshops.

To date, Sub-project 1 has issued two publicly available reports: a SWOT analysis for the fibre-based packaging supply chain and a review of

Some attendees enjoy a technology mapping event at DTI in Denmark

the current evidence on the health and safety implications of nanotechnology. These and all future public reports can be found on the website, SustainPack.com.

Sub-Project 2 Update: Lean & Effective Fibre-based packaging

Nanotechnology to Improve Packaging Strength and/or Reduce Material Use

Sub-project 2 leader Tom Lindström

The objective for Subproject 2 is to increase the dry, moist, and wet strengths of fibre-based packaging materials, enabling design of more cost-effective packaging by using less material. The target material reduction is 30%. However, this objective cannot be reached through evolutionary developments. Instead, new, revolutionary and innovative technologies must be used, such as nanotechnology (more specifically cellulose nanofibrils) for reinforcing packaging materials. These new technologies must then be implemented for practical use in paper mill operations. Therefore, supportive technologies have to be developed in parallel.

Facility for the manufacture of kilogram quantities of cellulose nanoelements

Paperboard development

The overall objective for paperboard development is to increase the bending stiffness of paper and board by 30% by using fibre engineering in conjunction with different nanostructuring technologies. The strategy chosen for reaching this overall objective focuses on increasing the delaminating strength of paperboard.

Linerboard development

The basic problem addressed in linerboard development is the collapse of boxes under moist conditions (see picture). The overall objective will be to increase the moist compression strength of linerboard by 30% (whilst maintaining fracture resistance).

Collapse of boxes under moist conditions

Sub-Project 3 Update: Fibre-based composite films

The main goal of Sub-project 3 is to develop composite films based on renewable polymers which can be used as a single layer in packaging applications, removing the need for lamination to other materials. The resulting composite films must exhibit good barrier and selective permeability properties, with thermal, mechanical and optical properties that make them attractive to the industry as well as the consumer (e.g. transparent paper etc).

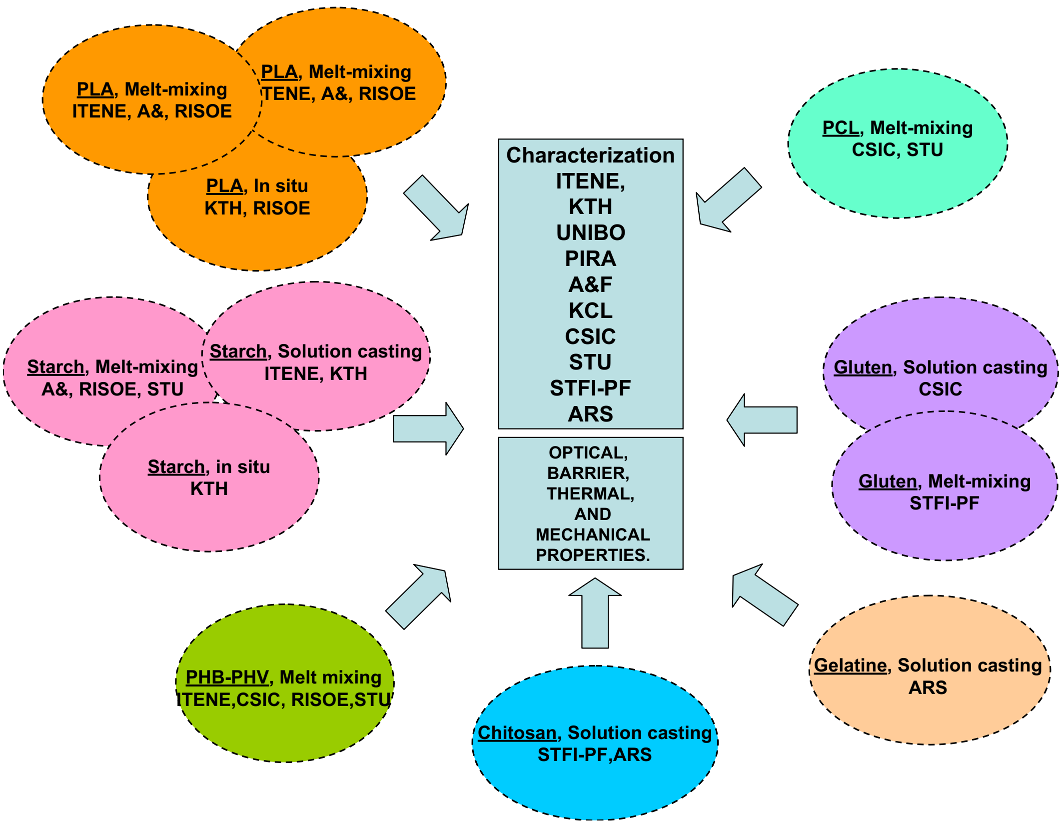
Sub-project 3 leader Susana Aucejo

In order to develop such innovative materials, combinations of several renewable polymers with different additives are to be studied by the different groups. Three different approaches have been taken:

1. The first is the development of combinations of mineral nanoparticles from clay (known as nanoclays) with blends of polymers.
2. Secondly, new materials will be developed by combining renewable polymers with nanofibres. For this purpose, various processes to obtain nanofibres will be researched.
3. Thirdly, both nanofibres and nanoclays will combined with polymers.

The materials developed will be characterised in terms of their barrier, optical, thermal and mechanical properties and their suitability as food contacting materials will be assessed. Finally, the commercial processing and scale up conditions from laboratory level will be optimised.

At the present time different partners are busy in material development. The renewable materials will be combined with nanofibres (provided by STFI-Packforsk) and commercial nanoparticles (coming later from developments by Sub-Project 2) using different processing techniques such as melt-mixing, in situ polymerisation and solution casting.



The distribution of tasks among the different groups

Seven different materials have been chosen:

- polylactic acid (PLA)
- polycaprolactone (PCL)
- starch
- gluten
- polyhydroxybutyrate-polyhydroxyvalearte (PHB-PHV)
- chitosan
- gelatine.

In parallel, those groups involved in the development of the new materials are currently characterising commercial films in order to standardise the parameters to be measured.

Sub-project 4 Update: Protective Coatings

Sub-project 4 leader: Professor Lars Järnström

There are twelve partners involved in Sub-project 4 working on the development of new innovative materials and combinations of materials for enhanced protection by surface treatment or printing.

Aim of Sub-project 4

The overall aim of Sub-project 4 in SUSTAINPACK is to develop new coating and printing technologies for protective properties, i.e. barrier and mechanical resistance. These new technologies are based on biopolymers and nanocomposites. An objective is also to tailor materials in order to obtain a desired set of properties suitable for a given application and to meet consumer needs and perception. For coatings, some of the concepts to be further investigated are:

1. enhanced performance by nano-sized materials
2. hybrid polymer/organosiloxane based functional coatings,
3. microencapsulation and
4. smart polymers with properties that easily can be trigged by some ambient condition.

In the printing area an important issue is local reinforcement in order to minimize the damage during converting steps such as cutting and creasing. However, several of the developed coating materials systems may be applied at a printing press as well. The work will address aqueous coating and printing systems. The raw materials used should either already be approved for contact with food or have a high possibility of approval upon application later on.

Example of results obtained so far

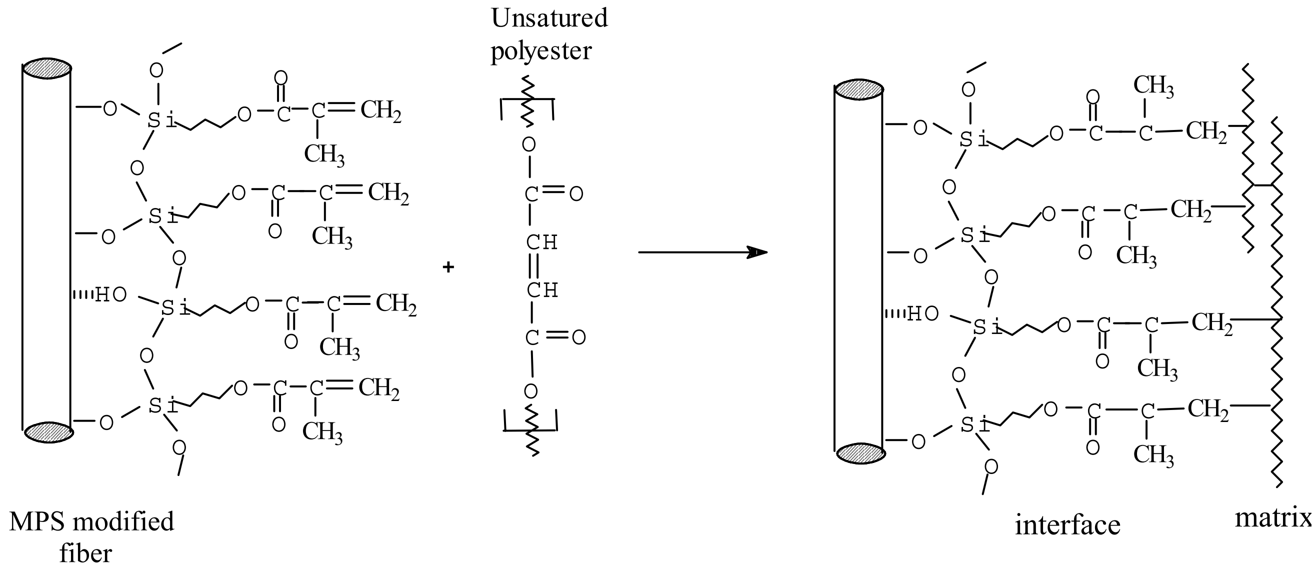
Several types of coatings and microencapsulated agents for water protection have been developed at the laboratories of the participating organisations. These will be further optimised into coating and printing formulations and investigated by a screening protocol that has been recently established. The screening protocol defines a methodology common to all the Sub-project 4 partners to check the properties of the packaging materials produced with the new innovative coatings. An overview has been created to give a summary of the packaging products available on the market today. The properties required by these packaging products are described as well as the existing tests to control the packaging characteristics. The screening protocol is based on this overview and will be continuously improved over the lifetime of the project. It is assumed that it will be a useful tool for the European paper and packaging companies in product development and selection.

CTP's curtain coater

Sub-Project 5 Update : 3D Composites

Apart from certain established segments, such as egg-cartons, there are today very few 3D-packaging materials on the market. One aim of the Sustainpack project is to create such packaging through the development of new 3D-formable cellulose-based composites which would provide viable alternatives to petroleum-based cushioning and packaging applications.

Sub-project 5 leader
Christine Chirat



Surface treatment combining a modified fibre and unsaturated polyester to create a 3-dimensional cross-linked (i.e. a matrix) polymer with properties such as surface inertness and insoluability to make the coating safe for food contact for example.

There will be at least two approaches to meet this goal. One is the development of nano-structured composites combining cellulose fibres or nano-components with a thermoplastic natural/ biodegradable polymer. The other is a controlled in-depth modification of lignocellulosic fibres.

SP5 consists of three technical activities
The first activity consists of developing different methods for modification of cellulose fibres, suitable for the production of composites with less than 40% of matrix material. The investigated methods include:

- surface and in-depth chemical modification,
- mechanical modification and changes in properties due to moisture absorption and temperature change (hygro-thermal) and
- ways to produce cellulose fibres/inorganic nanoparticles hybrids.

The second activity deals with the processing of composites based on the fibres modified in the previously described work and with the development of a 3D formable cellulose based material for cushioning. After the selection of the polymers for the composites, different processing routes will be tested.

Finally, in the third activity, the modified fibres and the composites prepared previously will be tested to assess their recycling ability or organic recovery ability, to evaluate them for food contact application, and to characterize their mechanical and hygro-mechanical properties.

Sub-Project 6 update: Communicative Packaging

Communicative packaging
The main objective of packaging is to protect its contents from the factory all the way through the distribution channel up to the moment of use. Of secondary importance is the communicative aspects of the packaging. Sub-project 6 is dedicated to technology development and implementation for communicative packaging.

Sub-project 6 leader
Ingrid Wienk

Four aspects of communication can be identified:

- Appeal & information,
- Identification,
- Anti-counterfeiting and
- Quality Indicators.

Appeal & information

Packaging has to convey a message in order to sell the product. This more so if the packaging material, such as cardboard, is not transparent and therefore obscures the contents. The message goes far beyond telling what type of product the packaging contains. To attract

A temperature and relative humidity sensor monitors the conditions in the distribution chain of tomatoes.

the attention of potential buyers, a package has to communicate better than the neighbouring packages. In 70% of cases, consumers decide what product to buy whilst in the shop. Development of an electrically switchable image printed on a cardboard box is a Sustainpack activity that will give brand owners the opportunity to distinguish their packages from those of their competitors.

Legislation requires all ingredients and their origins to be mentioned. To fit all such information on the packaging, the fonts have become smaller and smaller but people with impaired sight such as the elderly, the numbers of which are rising yearly, may have difficulties reading this information. A coded print, in the form of a 2-dimensional barcode that can be decoded with a mobile phone, could be a solution to this problem. This technology is being developed in Sustainpack.

Identification

Tracking and tracing of products should be common practice these days. The General Food Law, applicable from 1 January 2005, dictates that all players involved in food business operations must at least be able to identify the immediate supplier of a questionable product and the immediate subsequent recipient. In communicating the identity of a product, RFID is expected to replace barcodes in the coming years. Sustainpack is working on sustainable alternative RFID tags involving ink-jet or flexo-printing and conductive polymer materials.

Anti-counterfeiting

Counterfeiting activities constitute a major problem for consumer goods producers around the globe. Figures from the EU show that customs seized almost 85 million counterfeit or pirated articles at the EU's external border in 2002 and 50 million in the first half of 2003. Anti-counterfeiting methods always need to be at the cutting edge technology to stay ahead of the criminals. In Sustainpack, anti-counterfeiting technologies are adapted and new concepts developed for use in and on cardboard packages.

Quality Indicator

The quality of many food and pharmaceutical products depends considerably on the temperature and relative humidity at which the products are kept. Sensors monitoring these conditions can communicate values indicative of the product quality. Though sensors for temperature and relative humidity have been available commercially for some time now, Sustainpack will develop cheap and reliable alternatives to enable large-scale introduction.

Quality can be communicated to customers to emphasise quality standards and among supply chain partners to optimise distribution chains and prevent product loss. The resulting savings can be considerable - even in a highly-developed country such as The Netherlands, stock loss due to unacceptable quality is estimated to be 5%-10% of turnover.

Nanotechnology

Nanotechnology - how big or how small?

If a definition of technology is "the application of science and scientific knowledge for industrial or commercial objectives," then in its most simplistic form, nanotechnology might be specifically defined as "the application of science and scientific knowledge, at the nanoscale, for industrial or commercial objectives." In order to understand the size of material/matter involved at the nanoscale level, one needs to trace down the units of measurement, commencing with an ant (at the milliscale) and ending at the very bottom, at the nanoscale. The nanoscale is far from the smallest unit of measurement - it is however the smallest scale at which matter can be manipulated. Figure 1 illustrates where the nanoscale fits in with relation to other scales.

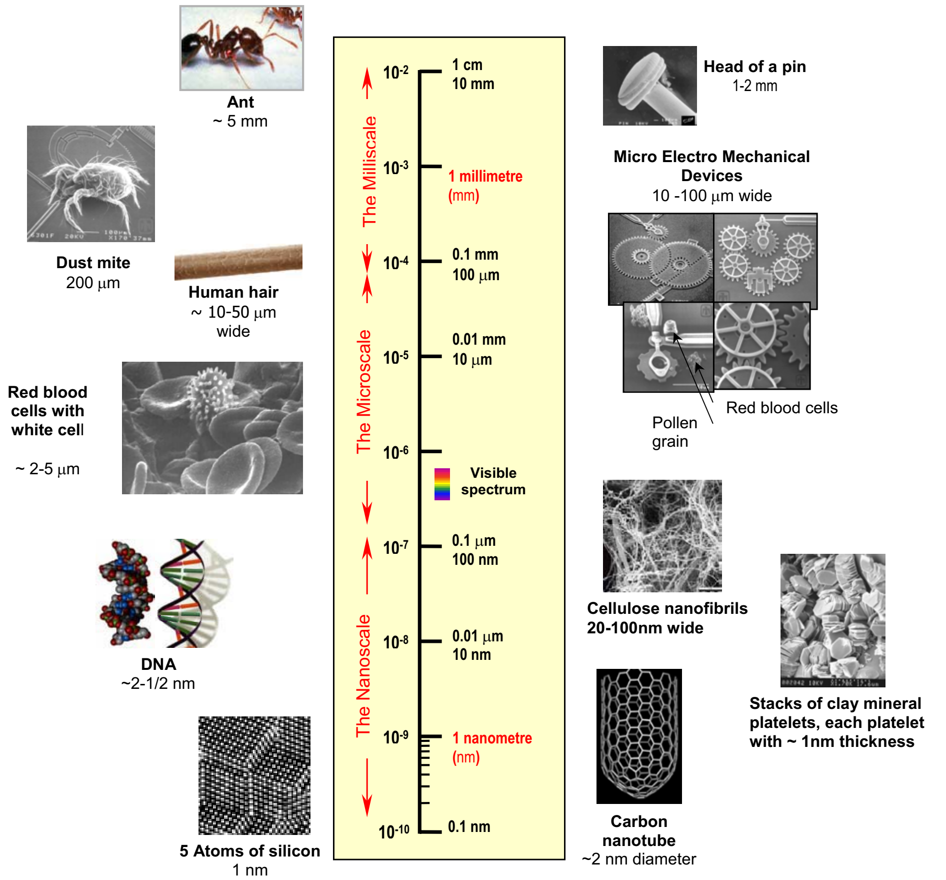


Figure 1 The size of nanotechnology

Nanotechnology - the manufacture

In terms of techniques for manufacturing nanoscale materials, there are two different approaches, bottom up and top down. Figures 2 & 3 gives examples of each approach.

Top-down refers to making nanoscale structures by machining and etching techniques, whereas bottom-up, or "molecular nanotechnology," applies to building organic and inorganic structures atom-by-atom, or molecule-by-molecule.

Nanotechnology - the applications

Many believe that the scientist K. Eric Drexler popularised the word nanotechnology in the 1980's with his fictional writings on the construction of machines built on the nanoscale - machines such as miniature submarines capable of being transported through the human body. However these have not been the only application for nanotechnology, because the nanoscience behind the technology is now recognised as having "general purpose" potential. When the technology is essentially fully mature, the manufacture of products from nano-scale materials will significantly impact virtually all industries and all areas of society. Yet with all the hypotheses and press releases covering nano-machines, nano-robots (nanobots) and suchlike, it is not surprising that nanotechnology is usually associated with science fiction scenarios - the reality is far from this. The manufacturing techniques and manipulation tools used in nanotechnology are already deemed suitable for the improvement and development of molecular medicine, biotechnology, advanced materials and other indirect applications relating to the environment (i.e. energy & pollution reduction). Currently the general trend is towards the use of nanotechnology within the area information and communication technology (ICT), especially focused upon the miniaturisation of electronic systems.

For many scientists, working with materials at the nanoscale is nothing unusual. Chemists and physicists have been analysing and manipulating (combining/splitting) materials at the nanoscale for decades. Recent developments in the tools used to characterise and observe nanoscale materials have led to an increased understanding

Lithography	Cutting / Etching / Grinding
Electronic devices; Chip masks	Precision engineered surfaces
Quantum well lasers; Computer Chips; MEMs (micro electromechanical systems)	High quality optical mirrors.

Figure 2 Top down manufacturing

Chemical Synthesis	Self Assembly	Positional Assembly
Particle; molecules	Crystals; films; tubes	Experimental atomic or molecular devices
Cosmetics; Fuel additives	Displays	
Main applications: Structural; Skincare; ICT; Biotech; Instruments; Sensors; Environmental filtration		

Figure 3 Bottom-up manufacturing

of their behaviour and properties. Such tools have been used to investigate some of the nanoscale materials that will be used in the SustainPack project i.e. nanoclays and nanofibrils. Details and potential applications for these materials can be seen in Figure 4.

Nanotechnology - the risks

As with any developing technology, there will be actual and perceived risks and associated fear so there is an urgent requirement to constructively and proactively debate these now, rather than wait until polarised views have developed - which are likely to damage any further advances in the technology. It seems likely that although there is much political support for nanotechnology, a repeat performance of the handling of Genetically Modified Organisms (GMOs) use in agriculture - should be avoided at any cost. Therefore, thorough risk assessments of the advancements in nanotechnology should almost be as important as the technology itself. For example, it is envisaged that it will be important to assess whole lifecycles via Life Cycle Analysis (LCA) tools, in order to evaluate the net benefits for environmental improvements. Such evaluations will be required to ensure there is not an increase in burden further down the supply chain, in disposal etc.

The technical challenges should by no means be underestimated. They comprise the following:

- Scaling up from lab to industrial scale
- Understanding the properties involved with nano materials
  Converting the science into application
- Regulating, standardising, classifying and risk managing

Summary

Developments in nanotechnology are some of the most important scientifc developments in recent years, with many industries, including the packaging industry being set to benefit. In parallel there is now also a need for informed and rational debate to ensure those involved, apply nanotechnology safely to their products. The SustainPack project seeks to identify and advance the application of nanotechnology to unlock these benefits.

	Description	Applications
Nanoclay	~1nm thick sheet like minerals, which naturally form in stacks and can be split apart into the individual platelets	The split (exfoliated) stacks can be blended with renewable polymers to produce plastics with enhanced properties
Nanofibril	20-200nm diameter chains of cellulose molecules that form the cellulose fibres found in paper	The cellulose chains can be blended with other materials to give enhanced properties

Figure 4 SustainPack nanomaterials

Project partners

Research organisations

Acreo AB, Sweden
Agrotechnology & Food Innovations, Netherlands
Centre Technique de Papier, France
Consejo Superior de Investigaciones Cientifica, Spain
Danish Technology Institute, Denmark
Forschung e.v, Germany
Fraunhofer Gesellschaft zur Forderung der angewandten
Institute for Surface Chemistry, Sweden
Oy Keskuslaboratorio - Centrallaboratorium Ab, Finland
Packaging, Transport & Logistics Institute (ITENE), Spain
Papiertechnische Stiftung, Germany
Pira International, UK
Risoe National Laboratory, Denmark
Stazione Sperimentale Carta, Cartoni e Pasta per Carta, Italy
STFI Packforsk, Sweden (Co-ordinator)
Technical Research Centre, Finland

Universities

Alma Mater Studiorum, Universita di Bologna, Italy
Ecole Fancaise de Papetiere et des Industries Graphiques, France
Helsinki University of Technology, Finland
Karlstad University, Sweden
Royal Institute of Technology, Sweden
Sheffield Hallam University, UK
Slovak University of Technology, Slovakia
University of Agriculture of Szczecin, Poland
University of Aveiro, Portugal
University Bordeaux 1, France
Universitat de Girona, Spain
University of Oulu, Finland

Industrial partners

Ahlstrom Research and Services, France
Cartonajes Levante, Spain
Kappa Packaging Development Ltd, Netherlands
Sainsburys Supermarkets Ltd, UK
Smurfit WW Research, Europe, France
StoraEnso Skoghall AB, Sweden
Walki Wisa Oy, Finland
XAAR Jet AB, Sweden

Contacts

For general information about Sustainpack, please contact:
Kennert Johansson, Co-ordinator of Sustainpack, Email: kennert.johansson@stfi.se

For more information about the sub-projects, please contact the sub-project leaders:

SP1 Michael Sturges, Pira International
Email: michaels@pira.co.uk

SP2 Tom Lindström, STFI-Packforsk
Email: tom.lindstrom@stfi.se

SP3 Susana Aucejo, ITENE
Email: saucejo@itene.com

SP4 Prof. Lars Järnström, Karlstad Univeristy
Email: lars.jarnstrom@kau.se

SP5 Christine Chirat, Institut national polytechnique de Grenoble
Email: Christine.Chirat@efpg.inpg.fr

SP6 Ingrid Wienk, Agrotechnology and Food Innovations B.V.
Email: ingrid.wienk@wur.nl

For newsletter and website enquiries including adding your name to our email mailing list:
Editor: Sheena Bassett, Pira International Email: sheenab@pira.co.uk
Tel: +44 1372 802075