SUSTAINABLE UTILITY OF WOOD BIOMASS – CURRENT TRENDS AT VTT

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Business from technology

Biorefinery concept Structural Value of Biomass







Potential New Biorefinery End-products

Sustainable transport <u>biofuels</u>

• Liquid biofuels from lignocellulosics and waste

New chemicals derived from biomass

- Crystalline, chemical molecules (fine chemicals, chemical intermediates, food ingredients)
- Extractives/resins & other liquids/solutions (lubricating oils/greases, solvents, surfactants, softeners, enzymes, binders/adhesives)

New materials derived from biomass

- Solid, plastic-like utensils and tools
- Flexible, plastic-like and/or fibre-based materials (bags/packaging, films/coatings/barriers, pigments, fillers, nanoparticles)
- Solid construction/building materials (e.g. composites)





New chemicals and added value materials from biomass

Objective

To develop sustainable fractionation and conversion processes to obtain innovative and value-added biomass derived fibres, polymers and chemicals

- To characterize the chemical and technological properties of the novel products
- To promote the competitiveness of the industry in the area of paper, board, packaging, composite and chemical applications







Side-streams and compounds of interest

- Chemicals and added value materials from bark
 - Suberin derivatives for coatings, composites, adhesives and lubricants
 - Bioactive and functional components
 - extractives: tannins, stilbenes, terpenoids
- Upgrading of lignin and hemicellulose
 - Bulk chemicals (sugar acids ect. From black liquor
 - Lignin modification for chemical industry
 - Hemicellulose polymers for coatings, composites, adhesives and binders

Biobased components for novel paper, packaging and composite applications

- Nanocellulose and its applications
- Barrier materials
- Biopolymers



Converting – Materials, processes and products

Objectives

- Extensive development of materials, processes and equipment for converting of paper, board and other fiber based products
- Improvement of production efficiency and productivity in printing and converting
- Promotion of competitiveness of the industry in the area







Converting

- Added value applications or fibre based products
 - Bioactive paper including diagnostics, indicators, tampe-evident products etc.
- Household and similar papers (hygiene and tissue products, filters, etc.)
 - Development of totally biomaterial based hygiene products

New properties of food and consumer packages

- Increase of card board formability by addition of biopolymeric materials or by mechanical treatment
- Production of transparency to fibre based materials by addition of biopolymer based materials
- · Development of role of package as messenger

Development of industrial and transportation packages

- Development of on demand production of packages
- Utilization of ink jet printing as publication and manufacturing technique, for instance on demand decoration of products as well as manufacturing of indicators and codes.

Development of converting processes

• Flexible converting lines, concepting of converting line operating like machine tool, and which can be steered and operated by production control soft ware











Example Ink jet printed Oxygen Indicators

- On-demand, low-cost, easy storage of inks
- Visual and/or optically readable
 - for sterilised shelf stable products (indicator activated by heat). Based on indigo colorant
 - for fast moving consumer goods (indicator activated by volatile reducing agent, e.g. ammonia). Based on redox dye
 - Visual or optical (quantitative quality) reading
- Application areas
 - tamper-evidence of hermetically sealed food/pharmaceutical/cosmetic packages
 - evaluation of 'use-by' date in opened package
 - evaluation of remaining shelf-life of packed product







Communicative Packaging

- Packages have become an increasingly important medium of communication: Package is the messenger of product information, marketing messages, safety information, and messages for logistics needs.
- Digital printing gives an efficient tool to boost package communication with ondemand package production.
 - Printing variable information on packages
 - On demand package printing and packaging logistics
 - Value added consumer packages
 - Printed quality indicators (patented)
 - Quantitative code-indicators (patent applied)





Novel wood based products

Objective

- To develop added value and high performance wood-derived products for living, building, furniture, vehicle and consumer good applications by intelligent wood material selection and advanced tailoring of material properties
- To promote the competitiveness and renewal of forest sector by upgraded wood based product innovations and concepts









Novel wood based products

Wood based products with multifunctional, smart and high performance properties

- Increasing durability and functional properties
 - moisture barrier concepts
 - improved UV-resistance
 - easy-to-clean surfaces
 - bioactive surfaces with controlled release of activates
- Advanced fire retardation concepts tailored for wood products
- Light wood based non-woven products with advanced functionality

Wood-polymer composites with added value properties

• Products for buildings and living, vehicles, electronics, furniture, sports and leisure goods, infrastructure

Product concepts based on side and waste raw material streams

- High performance boards
- Intelligent selection and direction of raw material streams

Comprehensive wood product concepts with advanced durability properties

• Raw material, preservation, surface finishing, maintenance









Carefree wood and fibre surfaces with multifunctional properties

- Hybride nanocomposite coatings
 - thin coatings: nano scale 10 μm
 - transparency/hiding power
 - · density and/or controlled porosity
- Nanobarriers
 - · non continuous structures in wood surface
- Nanoparticles
 - · active particles in wood surface structure
- Controlled release of activates
 - activates encapsulated in stimuli responsive polymers





Alberius, CODIRECT SYMPOSIUM 2007, YKI: Combatting biological growth on architectural coatings

Tshabalala, M. A. & Gangstad, J. E. Journal of Coatings Technology, 2003. Vol. 75, No. 943, pp. 37-43.



Advanced properties

- •water-repellency and enhanced weather resistance
- •antimicrobial properties: bioactive coatings
- •optical properties; improved UV-resistance
- •prevention cracks: sensoring and self-repairing
- •barrier properties: moisture, water apour, VOC's



Example Moisture resistant, nanomodified wood surface

- Optimized barrier properties
 - Hindered penetration of water
 - Free drifting of water vapour
- Abrasion resistance
- UV and weather resistance







Wood fibres with improved properties – Needs and possibilites

Why?

- Improvement in processability
- Improvement in fibre materials and product properties
- To improve competitiviness



How?

- By genetic engineering of wood
- By raw material selection
- By mechanical processing
- By chemical modifications
- By enzymatic methods



Chemo-enzymatic functionalization of fibre materials

Principle of the method

- Activation of fibres and the new functionality by enzymatic or chemical means
- Chemo-enzymatic **bonding** of the new functionality
- Based on fast radical reactions
- Lignin-rich fibres as a target
 - Targeted bonding of new functionality
 - Retaining of fibre technical properties

Method can be exploited in

- Enhancing inherent fibre properties
- Creating completely new fibre properties

Functional properties added to fibres e.g.:

- Charge
- Hydrofobicity
- Conductivity
- Traceability





VTT Industrial biomaterials

technology | applications | business

 a growth oriented strategic VTT initiative (person years of R&D per year):

75py/2009

- **125py**/2013
- combines multidisciplinary know-how of VTT: biotechnology, nanotechnology, chemistry, coating, P&P, converting, construction, process and value chain modeling,
- strongly orientated towards break-trough applications and renewing businesses

Vision A globally leading research consortia the non-food biorefineries for material solutions



Industrial biomaterials

- Material biorefineries and -solutions which enable:
 - 1. Performing materials in packaging, building and appliances
 - 2. Through industrial manufacturing of sustainable chemicals
- The biomass based material solutions replacing the non renewable counterparts in performance, product life cycle, and which do not compete with food production.







VTT creates business from technology

