Eco-efficient packaging:

Material use reduction through high performance composites and barriers

PulPaper 2010
Messukeskus 2.6.2010 @ 12.20-12:40
Ali Harlin, VTT
New & Innovative

Main themes:

- **Eco-efficient packaging:**
  - Re-engineering and eco-design
  - Biocomposites and foam structures
    - Biobarriers and nanoparticles
      - Thinlayer stuctures
  - Biolatex and performance polymers
    - Nanocellulose
Fibrematerial themes

Production chain efficiency
- No more sub-optimization

Re-engineering concepts
- New materials and processes full-fill customer requests

New products
- Forest industry renewal
  - Printed media
  - Packaging materials
Industrial biomaterial solutions

- Added value in forest industry
- Biotechnology ja prosess chemistry
- Efficient production methods of today
- Emerging material solutions

Sustainable technology for non-food biomass.

Prof. Ali Harlin, VTT 2010 ©
Packaging Design Circle

Designer has marked impact on the sustainability

But what really counts is
From the 3Ps through 5Rs towards Sustainable solutions

- **Protect**
- **Preserve**
- **Promote**

**Rethink**
Analyze user behaviors and expectations

**Re-engineer**
Involve whole value chain

**Remove**
Optimize packaging without losing functions

**Reduce**
Reduce material without affecting performance

**Recycle**
Improve material re-enters – especially user point of view.
Stakeholders and concerns

- Consumers
- Brand owners
- Retailers
- Packing industry
- Package manufactures
- Material vendors
- Society (legislation)

- Health, family, own life
- Differentiation, imago, pirate products
- Sales, logistics, marketing, safety
- Clean, lean, JOT, quality assurance
- Cost, purity, on-demand
- Raw-materials, recycling, material safety
- Environment, product safety, waste

Functional and sustainable
Eco-efficient packaging materials

Drivers

Reduce

Renew

VTT offering
1) Lightweight packaging materials
2) High performance composites
3) Thin film barriers
4) Biobased latexes
5) Dispersion barriers
6) Bioplastics
Hemicellulose dispersions for coating and adhesion

Technology: KCL proprietary technology on fraction, VTT in-situ modification and cross-linking

Features and benefits:
- Internally softened hemicellulose with markedly more moisture stability than starch.
- Glass transition temperature has been adjusted between 42…136 °C.
- Improved film forming properties (thermoplasticity).

Applications and business potential:
- Dispersion coating for board and corrugates.
- When natural polymers provide added value and packaging where versatile barrier properties (e.g. grease, oxygen)
- Coating/Printability sets different demands for board surface hydrophobicity and thermoplasticity
- Useful also in biopolymer compounds
- Fast growing natural polymer segment (over 20% pa).

Prof. Ali Harlin, VTT 2010 ©
Evaluation of functional properties

Functional paper based materials: the sustainability and biodegradability
  - Oxygen and water vapour barrier properties
  - Grease proofness
  - Mechanical properties (strain and strength)
Structures with Nanocellulose and Nanoclay

- Layer by layer deposition of nanomaterials
- Strength and flexibility
- Barrier for e.g. wrapping paper
Reduction 90% in oxygen transmission of biopolymer film

Materials:
- Sugar Beet Pulp Pectin,
- Montmorilite
- Glyserol

Methods:
- Pectin and glyserol dissolved into water
- Nanoclay dispersed
- Cast to 40 μm films

Results: Oxygen transmission [cm³/(m²*24h)]:
- Reference pectin film 55 (50% RH), 1770 (80% RH)
- 2% PGV pectin film 15 (50% RH), 160 (80% RH)
Nano technology in thinfilm coating

Atomic layer deposition technique as a means to fabricate thin barrier layers on packaging materials has been demonstrated.

Result: significantly enhanced barrier properties towards oxygen and water vapour for polymer films and polymer-coated paperboards.

Innovative Contributions
In the future these materials could be produced by continuous ALD process which has been the matter of recent interest. There are already patents and ongoing developments of continuous ALD process.
Benefits and advances of biogenic products:

- Biofuels increases biochemical production
- General purpose plastics remain highly efficient
  - World economics and logistics requirements
  - Reduction of wasted goods, e.g., food
- Waste management in future: recycling and energy use

Benefiters:
- Brand owners find answers for their customer request on sustainable products
- Chemical and material companies find added value and stability against oil price

Our vision

Fibrematerials are renewing:

- Recycling enables efficient solutions
- Environmental risk reduction
- Synergy with plastics

Prof. Ali Harlin, VTT 2010 ©
Conlusion

- **Life cycle assessment and functionality:**
  - Importance of LCA in packaging design is increasing
  - Sustainable packaging is efficient

- **Biomass based materials are developing fast:**
  - Fibre materials performance improves and enhance recycling
  - Nanocellulose is to make a a breack through
  - Starch will find competition but remains leader
  - Synthetic biopolymers are valuable in special applications
  - Bioreplacement is a rising star

- **Impact of the materials**
  - Recyclability is required
  - Reuse – especiality energy use is increasing
  - Customer preference enhance sustainability commercial value
Combined solutions of VTT and KCL

- Innovative fibre materials
- Biopolymers from starch to biopolyesters
- Printing from flexo to digi
- Bioactive paper
- Coating from dispersion to plasma and nano
- Laser-processing
- Printed intelligence
- Logistics
- Life cycle research
- Product safety
- Value chain modeling
- Customer behaviour
VTT creates business from technology

Prof. Ali Harlin, VTT 2010 ©