Technology Transfer of Cellulose Carbamate Fibre

Ali Harlin Marjo Määttänen, Kyösti Valta, Sari Asikainen, Eino Sivonen, Airi Särkilahti, Petteri Kangas, VTT Technical Research Centre of Finland
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- Cellulose carbamate CCA development
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- CCA fibre business opportunities
- Recycling
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Regenerated fibres NABC

**Need**
- Concerns on cotton
- PES oil-based
- Viscose sustainable?

**Competition**
- Lyocell
- Ioncell, Biocelsol...
- Natural fibres
- Biodegradable textile fibers

**Approach**
- Wood based rawmaterial
- Environmentally friendly
- Simplified process
- Enabling recycling

**Carbamate Fibres**

**Benefits**
- Availability of pulp
- More land for farming
- Markedly reduced investment cost
- Reduced chemical costs

**Concerns on cotton**
- PES oil-based
- Viscose sustainable?
Forecast for the world demand for dissolving pulp

Assuming that constraints to cotton supply will continue

Source: Pöyry 2012
Environmental impacts of different staple grade fibers

- Production of synthetic fibres, PET and PP, uses about 90 GJ/t fibre, energy source mainly non-renewable
- Energy use of man-made fibers and cotton is between 55 -105 GJ/t fiber, renewable energy use is between 30 – 70%
- Global warming potential measured as emitted amount of t CO₂/t fibre is 50 – 100 times higher with cotton (2t) and synthetic fibres (2.8- 4.1t) than with viscose produced in Europe.
- Cotton fibres uses over 5500m³ irrigation water, whereas production of other fibres uses 75- 500m³
- Agricultural land use (0.8 ha/t) of cotton

World textile consumption

- Textile fibre consumption over 70 million tons/year
  - Over 40 million tons synthetic fibres

- The share of man-made cellulose fibres has increased and is about 4 million tons/year
  - Depending on economic growth, fashion trends, and cotton availability and pricing
  - Substitution i.e. cotton/viscose blends important driver

- Environmental reasons why the share of man-made fibres should furthermore increase

Source: Pöyry 2011
Focus on CCA benefits

- CCA production separated from applications
- Logistics similar to other cellulose derivatives and plastics
- CCA production favorable for current cellulose derivative industry or for dissolved pulp mill (new or value added product)
- Only minor investments for current viscose industry – major savings in operating costs (no gas formation – fast precipitation)
- R&D is done with industrial partners – for both CCA production and applications
Carbamate cellulose (CCA) background

CCA=alkali soluble cellulose

**History**
- Early patents in USA -30’s (urea derivative of cellulose)
- Objective to replace viscose technology (no CS$_2$-emissions)
- Competes with enzymatic technique, ionic liquids and NMMO technique

**Why and what in VTT since 2002**
- Spinn-off of “Mechano-Chemical” processing of natural based materials: dry state processing technology, solvent free
- Totally revised Cellca technology
- Environmental and occupational hygiene requirements
- Bio based product, recyclable material, new paper chemical
- Viscose replacement as a starting point
- Potential for novel applications
Multiple possibilities – or too many ways
Invention: Simplify existing viscose fiber line for CCA

- CCA 4-10%, NaOH 8%
- Solution chilled to +5C for long time storage
- Intensive/slow mixing
CCA development phases

- Cellca technology developed in Neste Chemicals
  - Active development 70’s and 80’s
  - Plant size test runs in Säteri (Company sold)
- VTT revised technology totally 2002
  - High consistency technology
  - Improved chemical efficiency
  - Several other applications
- CCA commercialization is ongoing
  - Piloted for Avilon 2011-13 (Bankrupted)
  - Further licenced to an company 2013-
- New development phase
  - Recycled fibre concept
    - 2 new EU projects
    - New Partners

Picture: Helena Raunio (Kauppalehti)
Novel idea: Recycle textile materials

Recycling renewable textiles

- Applying recycled raw materials
- Recycling textile to textile
- Replacing cotton

Applying recycled paper

- Need for cheaper and more sustainable raw material
- 60 million tons of papers and board recycled in EU 2010
- Recycling rate is about 70%
- 10 million tons of recovered fibres to Asia
New project creation: Trash-2-Cash

Designed high-value products from zero-value waste textiles and fibres via design driven technologies (HIZING)

Project proposal for the call: NMP 18 Horizon 2020

- To develop new materials and products via creative design from waste or industrial by-products
- To promote the development of the creative sector by providing technology solutions for exploitation of waste streams and design for recycling
- To integrate design, business and technology into a coherent discipline to establish new creative industries
- To reduce the use of virgin materials and landfill, and associated environmental impacts
Textile recycling: Schematic material flow

Used cotton
Recycled paper
Reg. cellulose
Used recycled material
Used textile Cotton/PES blends
Recycling process of used material
Recycled PET
Bio-PET
r-PET
Recycled paper
Conceptual test: CCA of RCF

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Demo: Fibre spun from recycled paper

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Benefits of 2bFunTex

- Essential for cooperation within textile research community
  - Sharing ideas
  - Partnering for projects
  - Dissemination of results
  - Empowering national programs with European competence
- Close contact to European textile industry through ETP link
  - Reorient research lines
  - Bring innovations to innovations

Textile Research Seminar had 2013 highest participation ever by combined effort of 2bFunTex and Finatex
Summary

- NABC Sustainability of regenerated fibres is based on renewable raw materials and environmentally friendly process.
- Cellulose carbamate CCA process has been developed over the years in several projects and consortia.
- Technology has proven a viable alternative for viscose process, and solving known environmental constraints.
- However, the requirement of efficiency has led to several base technology improvements which have made the contemporary solutions markedly different from those of 20 years ago.
- Now fibre quality and process operability has been shown to reach industrial requirements. CCA fibre finds business opportunities simultaneously with increased interest on sustainable and bio-based textile fibres as well dilemmas related to cotton environmental reputation and price rallies.
- The production of the staple grade fibres from recycled paper and board using environmentally friendly and sustainable carbamate technique was proven to work with rather good economic.
- ETP and 2BFunTex essential: cooperation within textile research community and active European textile industry of great importance.
VTT creates business from technology