Designing Cellulose for the Future II: Seminar days 18-19.5.2016

LUT Packaging research environment for moldable fibre-based webs

Kaj Backfolk, LUT

Helsinki 19.5.2016
Outline

1. The research team
2. Fiber-based moldable webs: From web to tray
3. Smart Packaging line & Novel testing methods
The research team

- Professors
  K. Backfolk; Biomaterials process technology
  J. Varis; Production engineering

- 2 postdoc

- 8 + 4 PhD students

- 10-12 MSc thesis workers

- 2 Project assistants
Fibre-based webs to moulded tray

- Base material development
- Substrate coating *
- (pre-treatment) *
- Printing **
- Substrate conditioning *
- Unwinding / Web transport
- Diecutting/creasing**/***
- (thermo)Formability ***
- (filling) / food –package interaction *
- Sealing ****
- Product quality inspection/analysis
- Transport / Storage (Stability)

Doctoral dissertations
* Sami-Seppo Ovaska, est. Nov 2016
** Katriina Mielonen, 2015
*** Panu Tanninen, 2015
**** Ville Leminen, 27.5.2016
Academic testing environment

- Before 2010: Standard test methods, modelling
- 2010-2014: Web-fed "adjustable" packaging line
- 2014 - : Advanced tool development, advanced testing methods, ...
LUT Packaging line: Die cutting module

- Roll fed cutting and creasing module (optional sheet feeding)
- Synchronized servo controlled cam mechanism
- Maximum blank size ca. 450 x 450 mm
- Maximum pressing force ca. 150 kN
- Magnetically attached counter tool
- Pressing force is adjusted by a moving bottom plate
- Pressing force is monitored by strain gauge strips
LUT Packaging line: Press forming module

- Blanks are moved to the press module by a rotating manipulator arm
- Synchronized servo controlled cam mechanism
- Maximum tray size ca. 450 x 450 mm
- Maximum pressing force ca. 150 kN
- Blank holding force is adjusted by electrically controlled pneumatic cylinders
- Heating elements are located in the female mold (max. temperature ca. 200 °C depending on moulds)
- Pressing force can be accurately monitored
ILPRA Heat Sealing machine

- Heat sealing and vacuum/modified atmosphere packaging (MAP)
- Tailored tools for paperboard trays
- Analysis of sealed trays:
  - Pinhole / leak detection using colouring solution (EN 13676 (2001))
  - Mocon Optech O₂ Platinum analyser (ASTM F-2714-08)
  - Witt Oxybaby O₂ / CO₂ analyser
  - Witt Leak-master CO₂ leak detection chamber
  - Microscopic analysis of tray flange
Variovac Thermoforming line

- Bottom Roll Width 423 mm
- Integrated Forming
- Modified Atmosphere Packaging (MAP) and Sealing Vacuum/Pressured Air or
- Optional Plug Assisted Forming
- Adjustable Heating (Pre-heating, Top or Bottom)
Complexity in tray forming

- mechanical action
- temperature affects material properties
- strain rate affects material properties

Drawing (stress, strain)
Friction
Sharp bending

$T = 40^\circ C$

$T = 200^\circ C$

Friction
Sharp bending

Drawing – comes from the friction
Contraction in crosswise direction

Kajanto, I., Dusseldorf 2003
Tray forming tools with sensors

- New tool developed for on-line measurements
- Tool equipped with 4 force sensors
- Online monitoring of ruptures
Minimold developed in ACel

- Max. size of the rectangular test tray is 90 x 80 x 35 mm (depth can be varied)

- Tray blank (140x150 mm) can be diecut from a laboratory handsheet (165x165 mm)

- Temperature of the moulds is monitored with three sensors

The tool set consists of four main parts: the male mould (1), the female mould (2), the rim tool (3) and the heating unit (4).
Minimold tests on Acel samples

- Functionality of MiniMold has been validated by testing commercial boards

- Elongation during forming can be approximated from tray depth

- In fixed blank mode, 5% elongation is typical for commercial materials

- Preliminary tests with experimental materials has been carried out
Investigation of wetting behavior

- Complex fluids, W/O, O/W emulsion
- Directional / non-directional wetting
- Curved surfaces
- Time dependent effects
- Wetting behavior as quality control

Crossing area of MD/CD creases, creasing with laboratory creasing tool Fastbind C-400

Scanning electron microscopy images on the cracks in the barrier coating layer due to cutting and creasing aligned to the machine direction of the sample
Dependence of corona treatment

- New test procedure
- Short time scale investigations
- Polarization, discharge effects, electrocoagulation
- Positive/Negative Corona effects

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Thank you!