“Coating and printing processes for the surface functionalization

... newest developments in coating and lamination for specialty films and flexible packaging”
Agenda

• Experience of KROENERT

• Samples for packaging application and machinery concepts

• Self dosing versus pre dosing technologies

• Summary

Source: Modell region Hamburg for Electro mobility
KROENERT company information

Company information
- Founded 1903
- 260 employee
- 80 Mio turnover
- Certified according ISO 9001

Machines for roll to roll processing
- Paper
- Films
- Metal foils
- Laminates
- Textiles

Application of coating media
- diluted in water/solvents
- 100% solid compounds
- waxes, paraffines, hotmelts

Coating media, e.g.
- lacquers, adhesives, silicones, PVdC
- resins, polymers, pigments
KROENERT Product range

Complete Coating Lines
- Design, Engineering, Production
  Erection and Commissioning

Coating Machines
- Multi Roller Coater, Gravure Coater, MPG
  Die Coater

Unwinding and Rewinding Systems
- Shafted and Shaftless, Automatic Splicing
  Roll Handling

Dryers
- Convection Driers; oil, gas or steam heated
  with rollers, belts or flotation nozzles
Applications for packaging products

- Protection of food and nutritional products
- Protection of medical and pharma products
- Transport packaging (electronic products)
- Heat and light reflective films and isolation films
- Encapsulation of electronic devices like OPV and OLED
- Solar film back-sheets
Applications – Trends in packaging

Waste and cost reduction

- Aluminum replacement
- Substrate thickness reduction
- Simplify of laminated structures
- Used of recycled materials (e.g. PET and PE)
- Recycling of mono-materials easier to realize
- Transparent barrier layers
- Trend from can to fluid backs
- Cost competitive solutions

Application area: Dry food and wet food
(liquid soups and sauces)

Substrates: PET, thickness 8, 9 and 10 µm

Examples of barrier layers needed for dry products:
9 µm PET-AlOx coated
- MTVR 0.4 - 0.6 g/m² & day
- OTR 0.3 – 0.7 cc/m² & day

Examples of barrier layers needed for wet products:
9 µm PET-AlOx coated
- MTVR < 4 g/m² & day
- OTR < 1cc/m² & day
Solutions for Aluminum Oxide coating layers (AlO\textsubscript{x})

Plasma Assisted Deposition of AlO\textsubscript{x}

LEYBOLD OPTICS PAK 2100T and PAK 3700T+

For high performance transparent barrier coating (AlO\textsubscript{x}) and high productivity Al metalizing.
Requirement for the process handling during wet coating

Function of the coating layers:

• Conserve the barrier layer
• Mechanical stabilization of the barrier layer
  • Scratch resistant
  • Tension stabilization
  • Improvement of the barrier function
• Printability of the barrier layer
• Sealability function for the barrier layer

The barrier function have to be stable during the entire further substrate handling!

• Sensitive tension adjustment because the ceramic layer will be destroyed if too much tension is added to the polymer film.
• Very accurate coating layer application – invisible and very smooth for inkjet printing processes.
• As less contact of guiding rolls to the AlOx layer as possible.
• All rolls in contact with the AlOx layer have to be driven.
• The alignment of the rolls have to very precise in order to avoid stress in the ceramic Al₂O₃ layer.
• Application of primer layers for lamination processes with other films.
Machine sample for double side primer or sealing application

- Working width: 1.600 mm
- Speed: 200 m/min
- Simultaneous primer and lacquer application
  - Fully automatic turret winding technology
  - One coating head
  - 1 dryer
Application for printed electronic

Printed electronic

- Labels with information transfer by Near Field Communication (NFC)
- Electro luminescent layers
- Electro chrome layers like used for the window shades in the Dreamliner B787
- Foldable electronic magazines and displays
- Printed boards and RFID-antenna
- Printed sensors
- Organic solar cells

www.boeing.de
Applications for display application

Use of release films for the production of touch panel

- OCA – Application of optical clear adhesives on a PET silicone liner
- Cover glass
- Release request for PET-film (25 – 200 µm) with:
  - Good transparency / low haze
  - Wide range of release strength
  - Anti-static properties
  - Precise adhesive coating process

Flat panel display protective films
ITO film with printed circuits

www.3M.com
Applications for organic and flexible PV
5 coating units with register control – CSEM Brazil

Largest OPV-line
Clean room class installation
Register steering
Contact less substrate guiding

Configuration for printed sensors

Thinfilm Sweden
Application for Pouch back isolation of battery packs

Lamination of
- Aluminum
- CPP
- Nylon
- PET
Application for Pouch back isolation of battery packs
Slot-die for ceramic coating for separator membranes

Ceramic coating development current status:

− Optimal coating mixture of the ceramic chemistry.
− Coating technology performed in a lab-scale
  • Single side coating tested
  • Coating technology defined
  • Web handling optimized
  • Drying method defined
− Testing of properties of coated /impregnated membranes at Brueckner side.
− Evaluation of the reached target specification at Brueckner side.
− Upscaling of coating equipment done from 150 mm to 500 mm working width.
− Thermal relaxing of the film for a better stability qualified.
High performance of the coating necessary:
- Coating absent of defects
- Cross-Web Distribution less than +/-1%
- Wet thickness less than 1 µm – dry less than 100 nm
- Coating thickness must remain constant over 24h of production
- Printing texture with highest resolution

Which coating and printing technique is suitable???
Self-dosing versus pre-dosing

Self-Metered Coating Techniques

Pre-Metered Coating Techniques

⇒ Self-Metered-Coating means that the applied coating weight depends on the process => e.g. Dip-Coating, Roller-Coating, Knife-Edge-Coating

⇒ Pre-Metered-Coating means that the applied coating weight does NOT depend on the process => e.g. Slot-Die-Coating, Spray-Coating
Slot die technology in different setups

- Slot-die technology characterized by:
  - Capillary forces acting between slot-die and the substrate
  - Distances between slot die and substrate of less than 200µm
  - Very low wet film thicknesses (~ 1µm) is possible at substrate speeds of less than 50 m/min

- Web-Tension-Mode
- Extrusion-Coating-Mode
- Bead-Coating-Mode
- Short-Curtain-Coating-Mode
- Long-Curtain-Coating-Mode

Distance:
- d = 0
- d < h
- d > 2 h
- d ca. 1 cm
- d > 1 cm
The calculation of coating windows helps to control the process.

The following parameters are important:

- Fluid parameters (viscosity, surface tension)
- Process parameters (distance between slot die and substrate, wet film thickness, substrate velocity)
- Lip length of the slot-die

$$m = \rho \cdot U_w \cdot h \cdot B$$

$m = \text{Massflow}$

$U_w = \text{Substrate Velocity}$

$B = \text{Coating Width}$

$h = \text{Wetfilm thickness}$

$\rho = \text{Density}$
Intermittent coating operation with slot die technology

- Slot die for full size or
- Slot die for stripes in length direction or pattern in cross direction
Intermittent coating operation with slot die technology

General coating accuracy with slot die

- Gap adjustment slot die to substrate: 0,5 µm steps
- Running precision coating roller: 1 µm
- Precision of speed adjustment: +/- 1 %
- Tension: +/- 1 N
- Coating weight variation: +/- 1 %
- Coating thickness accuracy: +/- 0,1 µm
- Coating thickness adjustment steps: +/- 0,1 µm

Intermittent operation features

- Coating accuracy from one to the other side: +/- 0,1 mm
- Coating accuracy start and stop with intermittted coating: +/- 0,6 mm
- Tolerance of the coating length: +/- 0,5 mm
- Coating width: +/- 0,1 mm
Intermittent coating operation with slot die technology

Adhesive application for precise encapsulation of electronic devices

Results:

- A precise adhesive application is also possible
  - with very viscos-elastic adhesives
  - with visco-elastic materials

<table>
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<th>Nr.</th>
<th>Type</th>
<th>SC [%]</th>
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<td>45</td>
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<td>2</td>
<td>2</td>
<td>65</td>
<td>Water</td>
<td>white</td>
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</table>
Roller application technology for printing & coating

Conventionell
gravure
printing racle
with
oszillation

⇒ Printing – contact with the substrate

⇒ Coating – contact or contact less

T-chamber for
gravure printing
and coating in
direct and
reverse mode
possible

Gravure printing
pan less pressure
chamber system
for direct coating
and printing

Pan less
pressure
chamber system
for reverse
coating

MPG 300
Gravure printing/coating technology

PRINTING TECHNOLOGY

- Engravure for min 2 pt textures
- Hexagonal cell engraving
- All kinds of line-engraving
- Structures engraving
Roller application with pressurized chamber technology

Coating technology with MPG

- Definition of coating weight by
  - Engraved roller design
  - Squeezing technology
  - Pressure in case of using a pressure chamber for coating material supply to roller

Viscosity range:

- > 1 – 1.200 mPas

Coating weight range:

- Less than 1 g/m² up to max. 120 g/m² wet (depending on viscosity and solid content)

Advantages

- Precise definition of coating weight

Viscosity range:

- > 1 – 1.200 mPas

Coating weight range:

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Advantages

- Precise definition of coating weight
Sample for gravure printing for OPV

- Printing of OPV-cells with gravure roller technology from Belectric
- Inverted solar cell
- Efficiency 3 – 4 %
- Enough energy production to produce the energy of the German pavilion

Source of information: The solar trees of Belectric – information exchange during the OE-A meeting in May 2015
Flexo printing technology

Laser engraved FLEXO PRINTING SLEEVES

- Defined flexo-printing technology with changeable printing sleeves.
- Precise coating material feeding with engraved rollers.
- Laser pattern of the sleeves for highest resolution.
Rotary screen printing technology

Precise printing processes
Compact pattern up to very fine and thin lines
Register steering

Layer 1 – engraved roller printing
Layer 2 – screen printing
### Comparison of the different technologies

<table>
<thead>
<tr>
<th></th>
<th>Screen</th>
<th>Flexo</th>
<th>Gravure</th>
<th>Offset</th>
<th>Inkjet</th>
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<td>Film thickness wet</td>
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</table>

Tim Claypole „Manufacturing methods and challenges for printed electronics“, LOPE-C 2014, Munich
Modern machine concepts for high functional tapes

Coating line installed in clean room class 1000
Modern machine concepts for high functional tapes

Special application:
- Clean room class 1000
- Different coating methods
  - Roller technology direct and indirect
  - Gravure coating direct and indirect
  - Commabar technology
  - Slot die and curtain coating
- Clean room dryer
- Winding technology – 4 unwinder and 3 rewinder
- Lamination with temperature steerable rollers
- Web cleaning

High performance coating line in a modern Technology Center

Lohmann
The Bonding Engineers.
KROENERT BMB DRYTEC
The Coating Machinery Experts

andrea.glawe@kroenert.de

See us at our booth No. A6/212