What it takes to make it work:
The OnVü TTI

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Overview

- Monitoring of the chill chain
- OnVu\textsuperscript{TM}: the basic idea and how it works
- The heart of OnVu\textsuperscript{TM}: label, UV light and filter
- The charging and labeling equipment
- The system label solution
- Conclusion and outlook
Monitoring of the chill chain

- Data loggers and RFID tags
  - Supply complete temperature history
  - Expensive compared to TTI labels
  - Reader required for RFID tags
  - Mainly for logistics, not suitable for consumer

- Time-temperature integrators (indicators)
  - Accumulate time-temperature history
  - Cost-efficient
  - Visual check, easy to use
  - Suitable for logistics and consumer
TTIs – important properties

- Color change of TTIs based on different chemical and biological principles
- Important for industrial application:
  - Activation mechanism
  - Storage conditions before application
- TTI activation by light: photochromic compounds (photo or phos = light; chroma = color)

![Diagram showing the transformation between leuco and colored forms of TTIs.](Image)
Spiropyran color fading in solution

- Lab experiment: spiropyran in organic solvent
- Activation by UV-LED
The OnVu™ TTI – the basic idea

- Photochromism in **crystalline state**!
- Color fading and activation energies of spiropyran crystals correspond to characteristics of bacterial growth
How does the OnVu™ TTI work?

① Before activation
② Activation by UV light
③ Color fading depending on time + temperature
TTI characterization by color measurement

- CIE Lab color system, measurement by spectrometers
- Characterization of TTI activation (= charging) and color fading

\[ E = \sqrt{L^2 + a^2 + b^2} \]
Charging energy and shelf life

- Starting color of TTI can be modified by charging energy
- High flexibility to match different time-temperature conditions

**Example**
OnVu™ B1 label, different charging energies, at 4 °C
The heart of OnVu™: label, UV light and filter

Filter required for reversible \(\rightarrow\) irreversible system

TTR: thermotransfer ribbon
The protective filter – UV absorption

- High UV barrier in the UVA range (365 nm)
The making of ... the OnVu™ label

- Identification of suitable pigments in R&D labs
- Colorimetric characterization of TTI fading under different conditions (charging energy, temperature) and definition of reference color
- Registration of pigments including toxicological testing
- Technical documentation (specification, handling & storage) and quality testing for each production step
- Special know-how for printing of OnVu™ labels required
OnVu™ label printing at Bizerba P+E

- Printing of active TTI using water based flexo ink
- Control of printing parameters is vital for constant high TTI quality
- Bizerba P+E is certified for the manufacturing of OnVu™ labels
Shine some light on me – the TTI charging equipment

- Development of new charging equipment for OnVu™ labels based on UV LEDs
- Integration of TTI charging unit into existing label dispensers of Bizerba
- Modification of thermal transfer unit for TTR filter application
- Extensive testing of the complete system under realistic conditions: TTI label + TTR filter + charging and dispensing equipment
OnVu™ charging and labeling equipment

- Industrial label dispensers from Bizerba
- GLP-TTI for manual label application (10 to 20 labels per min)
- LDI-TTI for automatic label application (100 labels per min)

GLP-TTI

LDI-TTI
The OnVu™ system label

- 2D matrix code on label with tracing data (charging date and energy, batch no., product shelf life)
Outlook

- Special label for visual check of the Logistics chain
- Development of TTIs for frozen food
- Development of TTIs for longer shelf life (3 to 4 weeks)
Conclusions

Benefits of the OnVu™ TTI

- Stable and reproducible color fading based on photochromic pigments
- Cost-efficient manufacturing of TTI labels
- Defined activation at the point of packaging
- Simple storage and handling of TTI labels
- High flexibility through variable charging
- Charging, filter application and label dispensing of OnVu™ labels under typical industrial conditions using one machine
The partners of the OnVu™ project

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Thank you for your kind attention!

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