



TECHNICAL SEMINAR 23-25 NOVEMBER 2022 InterContinental Barcelona

Jonathan Sexton – UVFoodSafe

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UVFoodSafe – what is it ?

UVFoodSafe is a cross industry group of stakeholders managed by FINAT focused on the UV printed label and packaging value chain




Vision Statement

"To create confidence within end user and converter communities in the use of UV printing in food packaging and labels through education and the provision of application specific best practice, enabling the consistent delivery of compliant print to the market."

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UVFoodSafe Group Structure

Steering Committee ; FINAT, Tarsus, Working Group Chairpersons, RadTech Europe

Working group 1 ; Process

- Establish the relationship between UV dose, ink cure and migration
- Optimisation and control of the printing and UV curing process
- Alignment with GMP ; production data and traceability for each print job


Working group 2 ; Print

- Pack and label design and migration risk assessment
- Materials selection (substrate, inks, consumables etc.)
- Print quality control, cure testing (FINAT test methods...)
- Print certification; sampling and migration testing

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Summary of Print group activities

- Ink curing test methods evaluated and recommendations made, **including a new standardised solvent rub test method**
- The VskE packaging and label risk assessment guidance document reviewed and adopted
- Materials selection and specification, supply chain communication (GMP) guidance developed
- Migration sampling and testing guidance developed
- Print test protocols defined together with the Process group for the practical test







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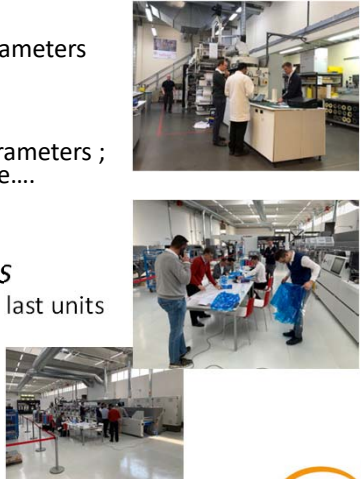
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Process group print tests


- **1st print test Sun Chemical 6th Feb 2019, single UV unit**
 - Evaluation of UV does measurement (strips, sensors), calibration of key parameters
- **2nd print test, Bobst 17/18th April 2019; single UV unit**
 - Assessment of UV curing tests and evaluation of key printing and curing parameters ; UV dose, UV intensity, ink coverage, film thickness and density, temperature....
 - Submission of first set of migration samples
- **3rd print test, Bobst 9th July 2019; single and multiple units**
 - Evaluation of curing limits ; opaque white, coating, black, reflex blue on the last units
 - Submission of further migration samples
- **4th print test, Bobts 13th Dec 2019 ; full print jobs**
 - Submission of migration samples



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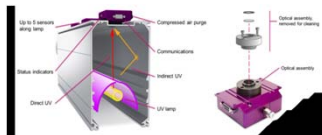
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Key conclusions from practical work to end 2019

- 1. In-line UV print cure testing** is critical to ensure consistent print production
 - In particular in the absence of other process controls
- 2. Commercially available UV dose strips and in-line UV irradiance monitors** are effective in-line process controls but need to be calibrated and accuracy noted (MSA.....)
 - Worst case scenarios can be used as a control method
 - Dose monitors are affected by reflected UV light from the substrate
 - LED wavelengths require specific UV strips and monitors (not yet tested)
- 3. Ink curing** is affected by **filmweight and temperature** (chill rollers)
 - Oxygen inhibition at low filmweights, insufficient through curing at high ink filmweights
 - The lower viscosity and higher filmweight of digital inks may thus impact curing and migration
 - Inhibition of curing at low temperatures
- 4. Dark colours** on the last print units are **critical, coatings** on the last unit may be critical




Source GEW

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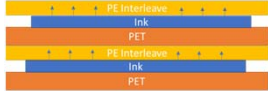
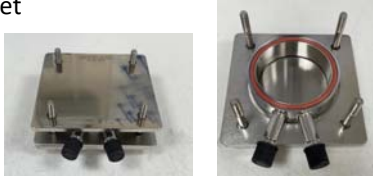
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Migration testing protocols

- Migration testing protocol ; plastic PP and PET
 - 95% Ethanol, 10 days exposure in migration cell (of the PE sheet for PET)
 - 40°C used in previous testing and 60°C (EU plastics regulation, long term storage)
 - Surface PP ; simulant in contact with reverse unprinted side of the film
 - Reverse PET ; EuPIA guidance for lamination simulation ; 10 day set-off conditioning at ambient temperature at 1kg/dm2 pressure, interleaved with PE film sheet
- Migration testing protocols ; paper
 - Tenax dry food simulant
 - 40°C, 10 days exposure
 - Simulant in contact with the reverse unprinted side of the paper
- Migration vs Specific Migration Limits (SML) according to the EU model (1Kg food in 600cm2 packaging) and reported in ppb migrated into the simulant vs the SML


Note ; testing protocols, particularly 60°C, are worst case scenarios.....

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Migration – potential sources

How does Migration occur?

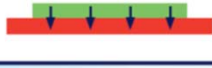
Substrate
Ink

- 1


Direct Migration
Direct migration from print to food, in situations where the food is in direct contact with the print


- 2


Through Migration
Penetration through the substrate to the reverse side of the print


- 3

Set-off Migration
Set-off from the print to the reverse side while being stored in a pile or reel


- 4

Gas Phase Migration
Volatilisation and condensation of components after heating




- Inks, coatings, adhesives
- Press cleaners, offset founts
- Substrate; film or paper
- Environmental contaminants
- Storage and transportation

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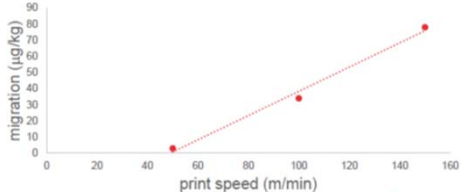
Migration testing summary 2019/20/21

- Increasing cure speed/reducing UV dose has a negative effect on migration (graphic below)
- Migration results on poorly cured black (<10 IPA double rubs) were better than expected, but not compliant
- Cure speed/dose had no influence on the migration (compliant at 40°C) from coating alone under the test conditions ; coating well cured by physical tests, ie. good correlation cure test to actual migration
- Coating has a positive impact on migration when printed over black, migration better than black ink alone
- Migration of the reverse white and reflex blue combination is worse than the white ink alone, even though the physical test on the white suggested full curing

In general, migration tests were sometimes borderline for compliance;

- High ink filmweight** in combination **with reduced dose** during printing represents a “**worst case**” condition
- Conclusion ; further tests would be made on commercial style prints*

Migration of AC-Component 5 as a function of print speed for samples 27, 28 and 29




Print Speed (m/min)	Migration (µg/kg)
50	10
100	40
150	75

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Process group – print test 5, 16th Dec 2021


Print test objectives and parameters

Produce surface and reverse typical commercial jobs and make migration tests, including obtaining an external certificate

- Print jobs ; combined on a single plate ;
 - Surface print PP – Vibrant design
 - Reverse print PET – Dog Food design
 - Surface print paper – Vibrant design
- Speed ; 100m/m and 150 m/m
- Lamp setting ; 144 w/cm and 180 w/cm

Press ; Bobst M6


- Flexographic 10 colour 670mm web
- GEW E2C-HP lamp @ at various power



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Combined surface and reverse print plate

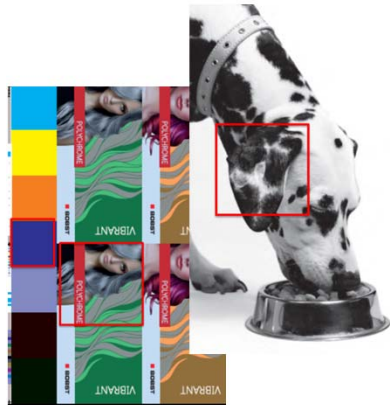
Surface print side




Reverse print side



Reverse white obscuring
dog food image




Migration sampling areas



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Migration samples selected for testing


		Print settings				Substrate		Lamp Settings	Cure results
Number	Print method	Plate design	Print station(s)	Press speed	face/reverse	Type	Material	Lamp power(s) (Wcm ⁻¹)	Solvent rubs (x2)
4	Flexo	Dog food	2,3,4,5,6,7,8,9	150	Reverse	Film	PET	144	100+
5	Flexo	Dog food	2,3,4,5,6,7,8,9	150	Reverse	Film	PET	180	100+
8	Flexo	Vibrant	2,3,4,5,6,7,8,9	150	Surface	Film	PP	144	100+
9	Flexo	Vibrant	2,3,4,5,6,7,8,9	150	Surface	Film	PP	180	100+
10A	Flexo	Vibrant	2,3,4,5,6,7,8,9	100	Surface	Paper	Raflacoat paper	144	100+

- Speed and lamp setting determined to represent commercial conditions
- Single unit dose at 100 m/m and 180 W/cm = approx. 160-180 mj/cm2
- All samples showed more than 100 IPA solvent rubs at end of press ; presumed fully cured
- Samples submitted to the two supplying ink companies for migration testing

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Summary of migration results print test 5

- **Paper** samples tested at **40°C, 10 days, Tenax** were compliant in migration testing conducted by both ink suppliers using similar analytical methodology for target ink components ✓
- **Polypropylene** samples tested at **40°C, 10 days, 95% ethanol** were compliant in migration testing conducted by both ink suppliers using similar analytical methodology for target ink components ✓
- Migration compliance was slightly better at 180 W/cm than 144 W/cm
- These testing protocols represent most labelling applications and many packaging applications, but final application testing is necessary to prove compliance

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Summary of migration results print test 5

- Migration compliance was not fully achieved in the worst case 60°C testing on the PP non-barrier material in both ink supplier's analyses, due to a small number of non conformances
 - The 60°C migration test condition is subject to a study commissioned by the ink manufacturers association Eupia, to establish the real correspondence to long term storage
 - Compliance might be proven with risk assessment in real packaging scenarios
- PET samples tested at 60°C were compliant (supplier 1) and non-compliant (supplier 2)
 - Migration testing using interleaved PE sheets may be more severe than real lamination due to the influence of sealing films and adhesives ; we will laminate prints in future before testing
- *Non-compliant levels of no-food UV photoinitiators not used in the supplier's inks were found in the printed samples by supplier 2, and in one case on the unprinted PP film area*
 - *Supplier 1 searched only for food packaging suitable components*
 - *Improved press preparation and sampling procedures are necessary in future tests*
- Due to contamination, it was not useful to submit samples to an external laboratory

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Migration testing ; conclusions to date

- Migration testing demonstrates that UV flexo inks can achieve food packaging compliance on paper and film in many label and packaging applications
- Achieving compliance according to plastics regulation long term storage at 60°C in the most challenging worst case conditions may need to be proven in specific packaging applications
- Food compliant printing needs strict GMP measures and sampling methodology to achieve reliable and compliant migration results
- FINAT will continue the UVFoodSafe work to refine methodology and to demonstrate third party certification
 - Further print testing is being sought at a converter running LM inks permanently

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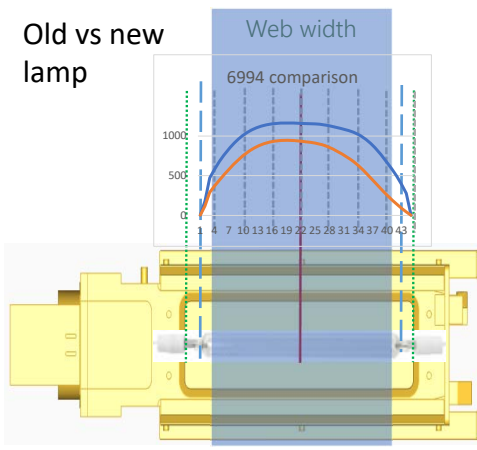
UV lamp monitoring

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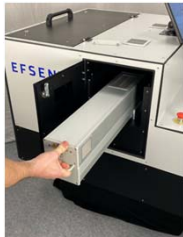
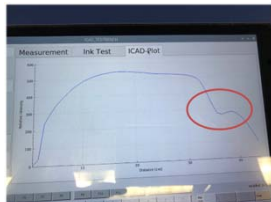
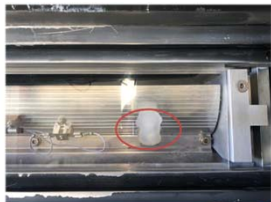


UV lamp characterisation using test bench – 2020 activity

Old vs new lamp




- Exercise run by Efsen UV and a large label printer
- Variations in output from lamp to lamp, lamp age
- Varying deviation from middle to sides ; web width critical !
- Large impact of ink stain or dirt on quartz window
- ”Cleaned” reflector does not reflect like new
- ICAD® compares to UV radiometer readings and UV-strips

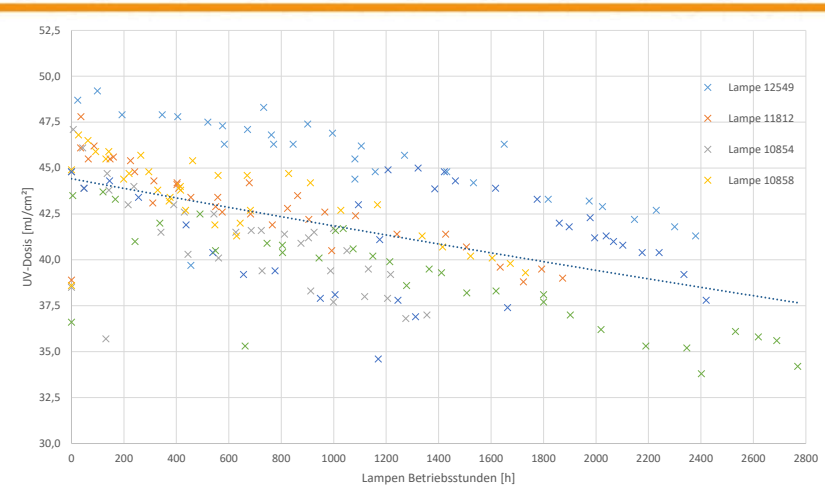
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Measurement values 6 lamps over 2000+ hours



Avg. degradation 15%


Spread from 35-49 mJ/cm2

Dose varies between lamps

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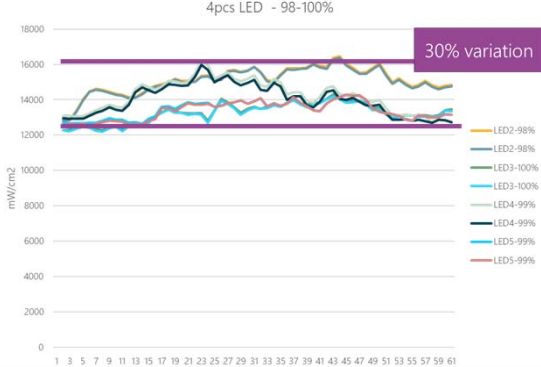
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Next step, in-line installation on an LED press

- Measure output on 8pcs LED inline UV flexo during production
- Sensor running in front of the lamp ; low (<10%) UV intensity reduction during sensor passage (<1s)
- Detection of dirt of ink stains on the window, other performance degradation

4pcs LED - 98-100%






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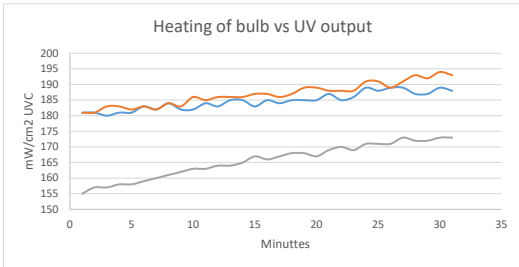



Mercury UV installation on multilamp unit

Installation of 3pcs ICAD on 3 mercury lamps on a multi-uv station to see how we could measure in hot environment and how the lamps would influence each other etc.

- Bottom left: Shows three lamps output change over 30min in one point
- Bottom right: Picture of a 3 UV Lamp station with ICAD integrated on each lamp

Heating of bulb vs UV output






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UV lamp monitoring ; conclusions to date and next steps

- Continue project to gather more long-term performance data
- Test further lamp to lamp variation and inter lamp influence
- Test lamp behavior over time (warm up and long runs)
- Confirm influence of substrate reflectance and print color reflectance difference on UV dose and dose measurement
- Evaluate and improve sensor data stability in harsh environments

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Key contributions

Thank you to the key contributors to UVFoodSafe;

		Noel Mitchell	
			FINAT Test Methods Sub Committee
			
			
			
			

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UVFoodSafe Consortium Members

Thank you to all the consortium members;

AMS Spectral UV/Baldwin Technology	GEW	Radtech
Avery Dennison	Henkel	Resino
AVT	Herma	Schmid-Rhyner
Bizerba	HP Indigo	Screen Europe
BOBST	Inx International	Siegwerk
Canon Production Printing Germany	IST Metz	Stratus Packaging
CCL Label	Mark Andy	Sun Chemical
Domino	Mirage Inks	Taghleef
Dow Corning	Mouvent	Tarsus
Durst Group	MPS	TLMI
Efsen	Nilpeter	UPM Raflatac
Etivoet	OMET	Xeikon
FINAT	OPM Group	X-Rite
Flint Group	Phoseon	Yerecic Label
Gallus Group	Pulse Roll Label	Zeller+Gmelin

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Thank you for your time



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