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Photo-Latent catalyst for rapid cure of 2K-PUR coatings

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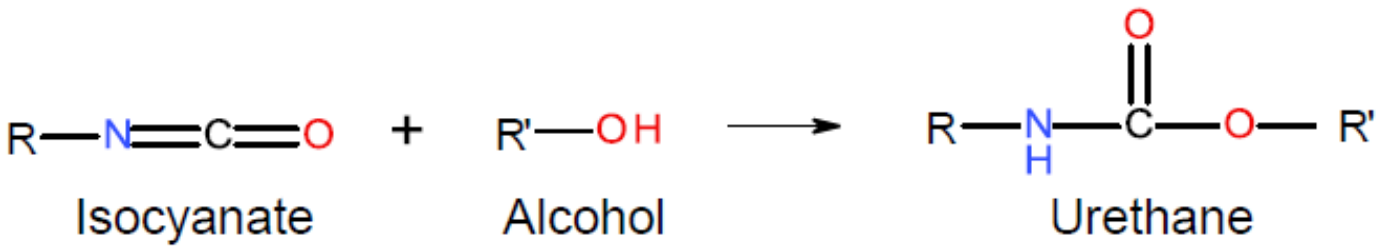
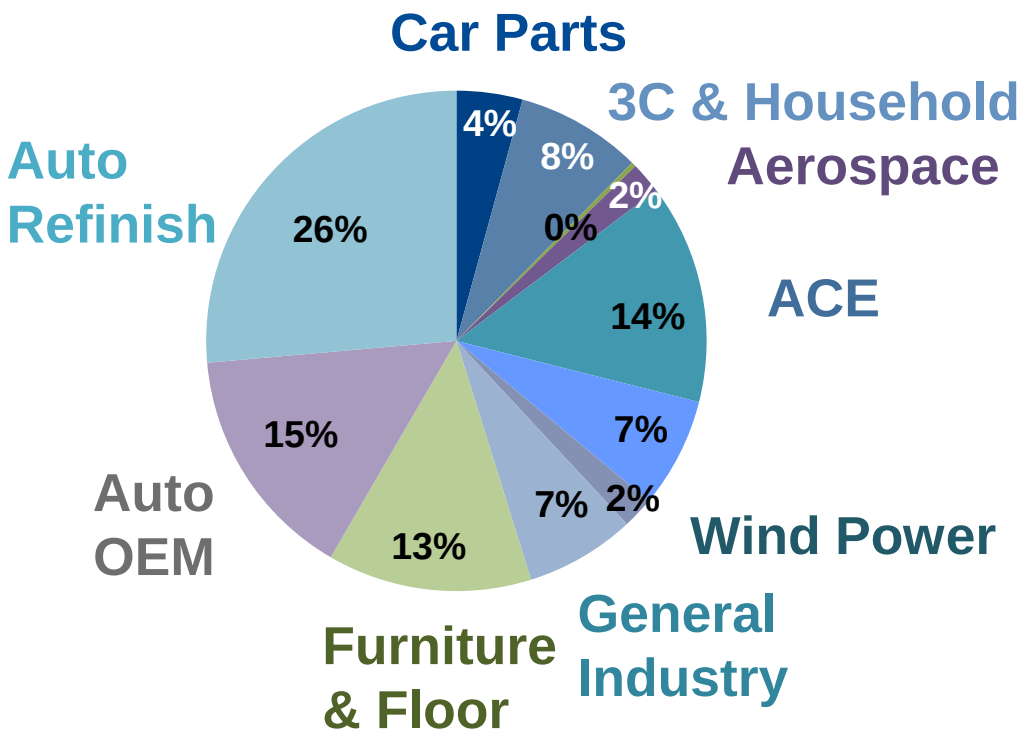
Overview

- 2K-PUR coatings and current challenges
- What is a photo-latent catalyst and why would one be used
- BASF approach
- Performance overview
- Summary

2K-PUR coatings



Coatings Market for 2K-PUR Global
~17,000 kT



- Good UV resistance with HDI
- Good gloss retention
- Good color stability

Current technology and challenges

Large objects

- Low temperature processing
- Need to reduce cycle and storage times

Heat sensitive substrates

Other Factors

- Low VOC emmision
- Tin catalysts like dibutyltin-dilaurate (DBTDL) have toxicological and environmental concerns.

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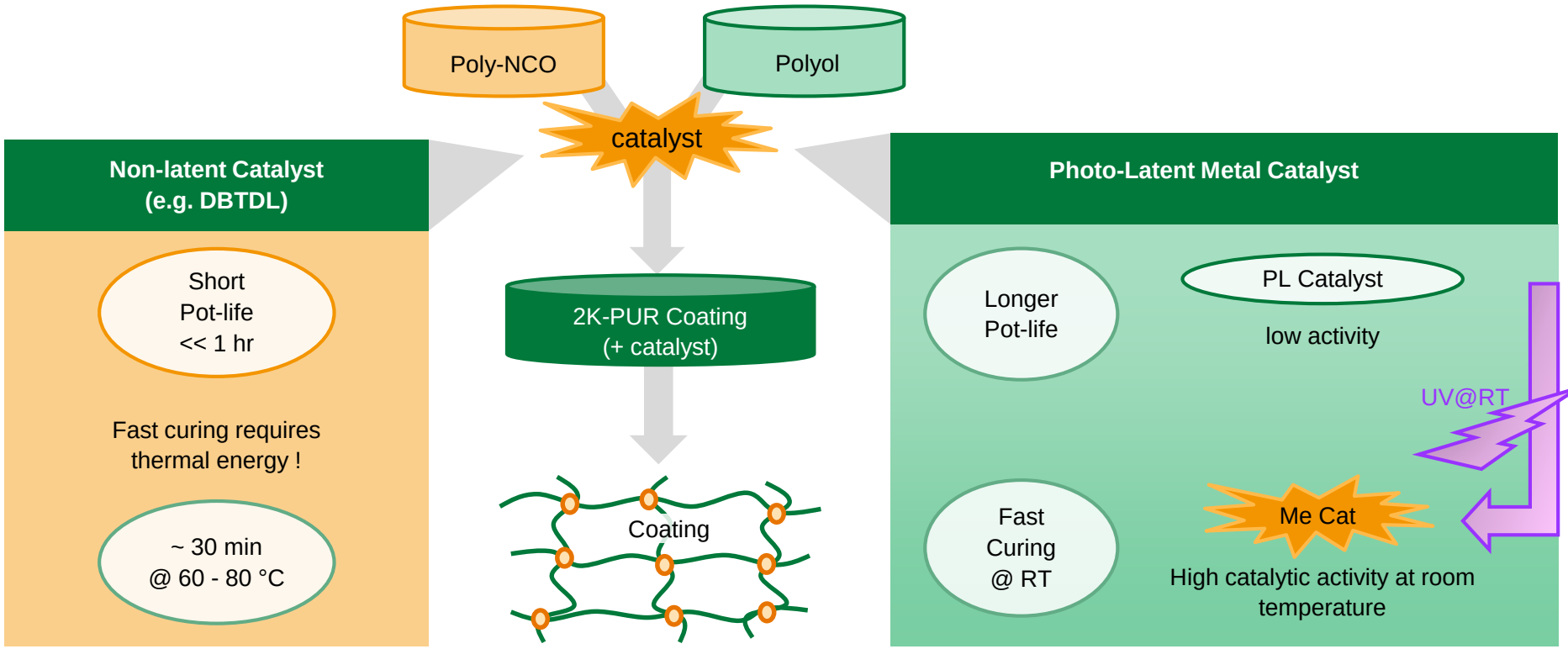
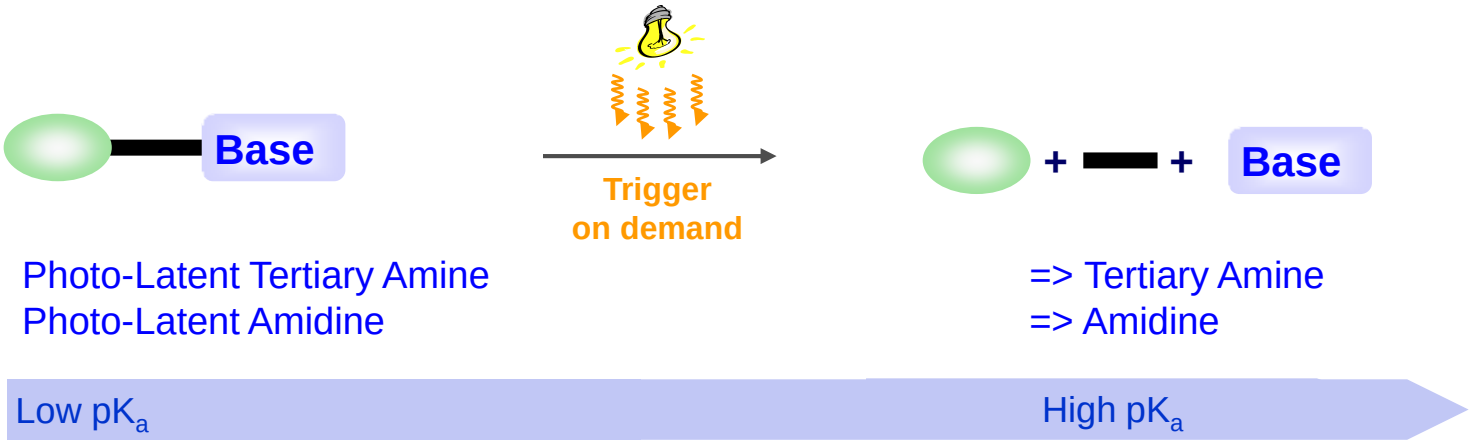
RT Curing of 2K-PUR with UV-light triggered Catalyst



Other Photo Latent Catalysts: Photo-Latent Bases

Provide pK_a Jump



The catalysts can be used as one-pack systems with long shelf life stability or as two-pack formulations with an extended working window, opening new possibilities for cross-linking mechanisms for the coating industry

Why a photo-latent metal catalyst?

Reduce energy consumption:

- Room Temperature vs. 60-80°C
- Addresses the issue of heating very large objects, heat-sensitive parts, or heavy metal structures

Increased throughput:

- Short time to dust-free
- Short time to handling/moving of coated object.

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Why a photo-latent metal catalyst?

Reduce Paint Waste

-Cure on Demand

-Pot-life > 1 hour

-Increased flexibility in process timing

Increased Environmental Benefits

-Organotin-free

-Cold-cure

-End of life recycling

Cure-on-Demand enables better economics;
Organotin-Free supports safer handling.

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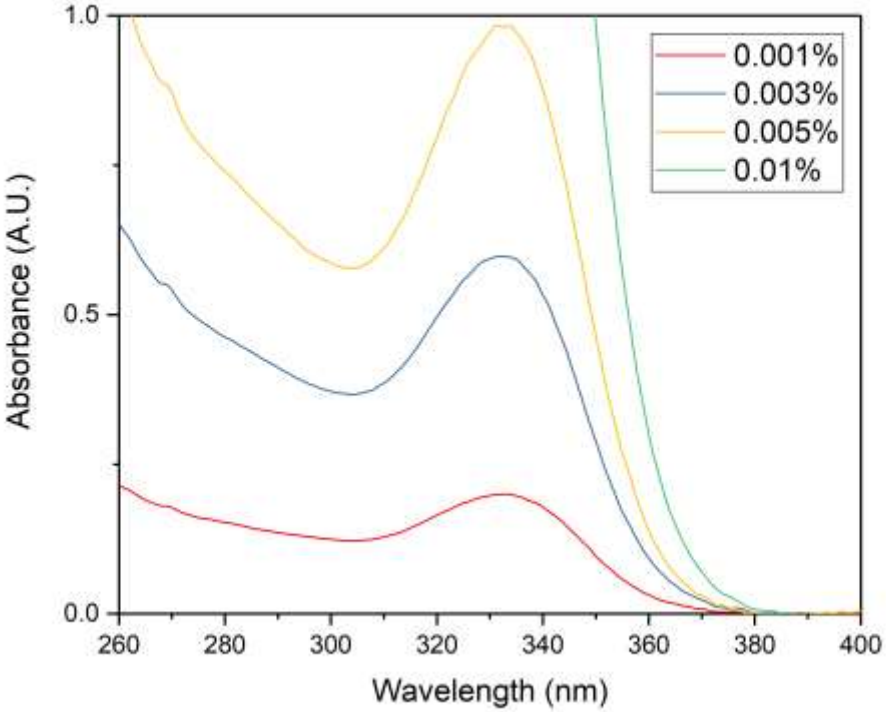
BASF photo-latent metal catalyst

- Physical properties:

BASF Photo-Latent Metal Catalyst	
Solids content	100%
Butylacetate	Soluble
Metal (non-tin)	~ 9.0%
Aspect	White crystals
Shelf Life	~ 1 year

- Good UV response and no photo sensitizer required for clear coat.
- AMES test: negative! ⇨ non-mutagenic
- TSCA listed

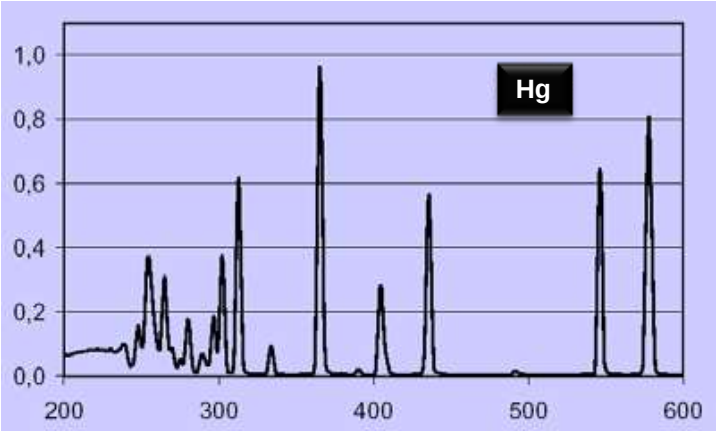
UV absorption of photo-latent metal catalyst



Catalyst was dissolved in Butyl Acetate for measurement.

UV-F450 “Flood Lamp”
(Panacol-Elosol)

HB-404
(Philips)



- BASF Photo-Latent metal catalyst has strong UV absorption under 380 nm.
- Product can be triggered by medium pressure mercury lamp, metal doped lamp or even LED lamp.

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Formulation for study

Component A	wt%
Acrylic Polyol	52.72
Leveling additive	0.60
Butyl Acetate	25.95
Component B	
HDI based Polyisocyanate	20.65
Catalyst	
Photo-Latent Metal Catalyst/DBTDL	0.005-0.08

- Formulation Characteristics
  - 63% Solids
  - Initial Viscosity ~65 cP
  - Isocyanate Index=105

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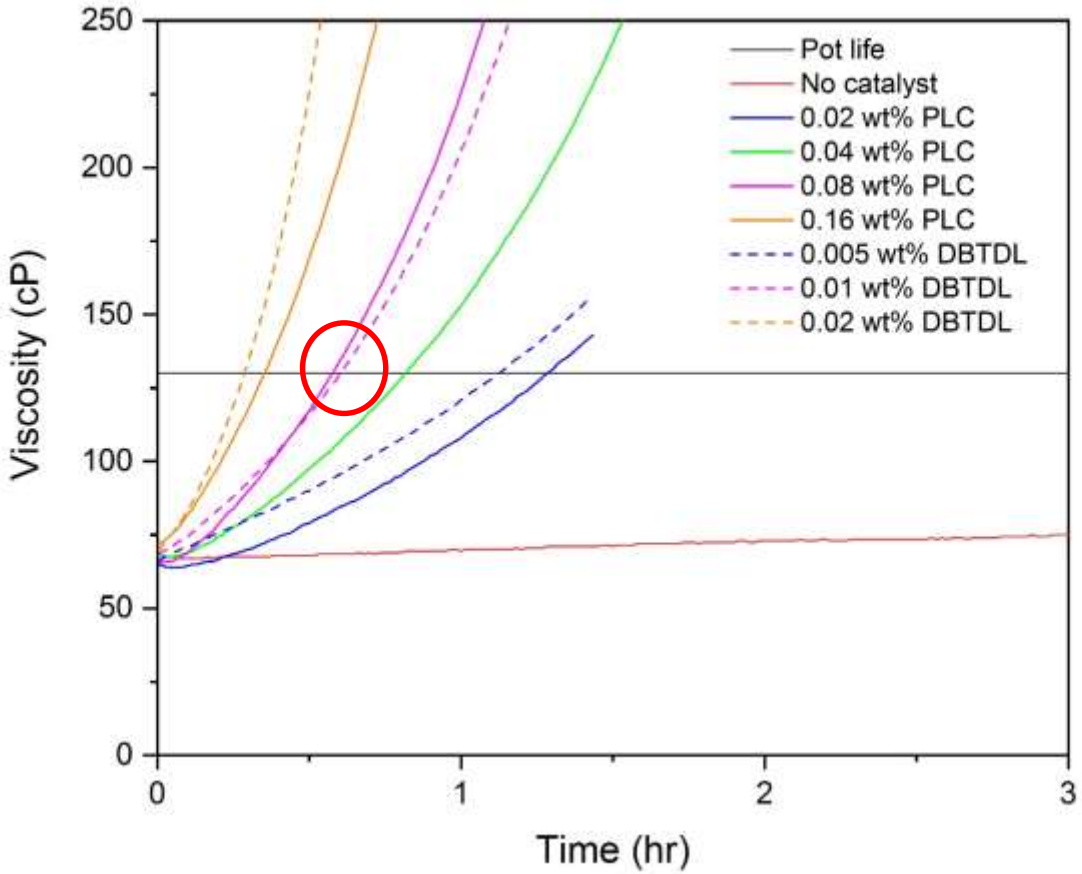
Pot life study



- If the catalyst levels are the same, 2K-PUR formulation with Photo-latent Catalyst had longer pot-life than DBTDL formulation.
- Formulations need higher loading of photo-latent catalyst to achieve the similar pot life.

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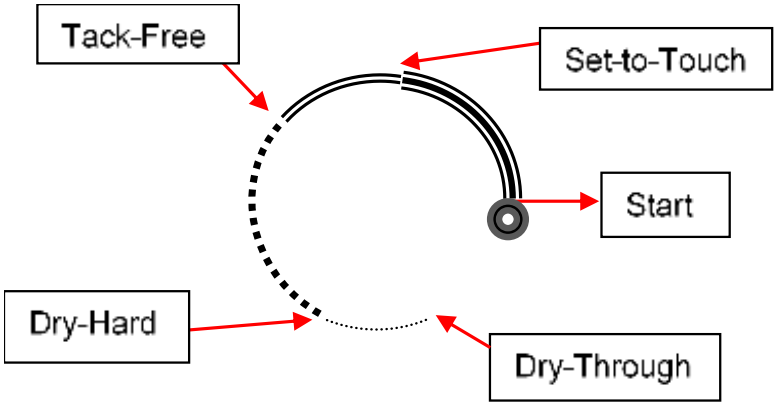
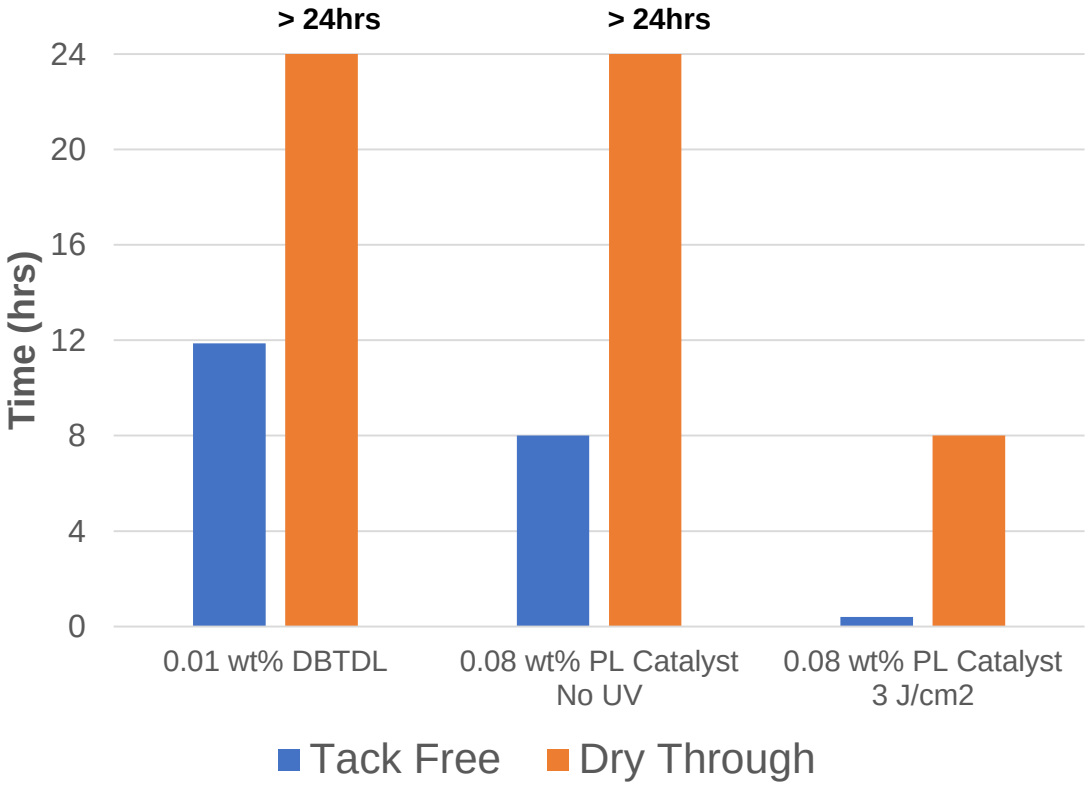
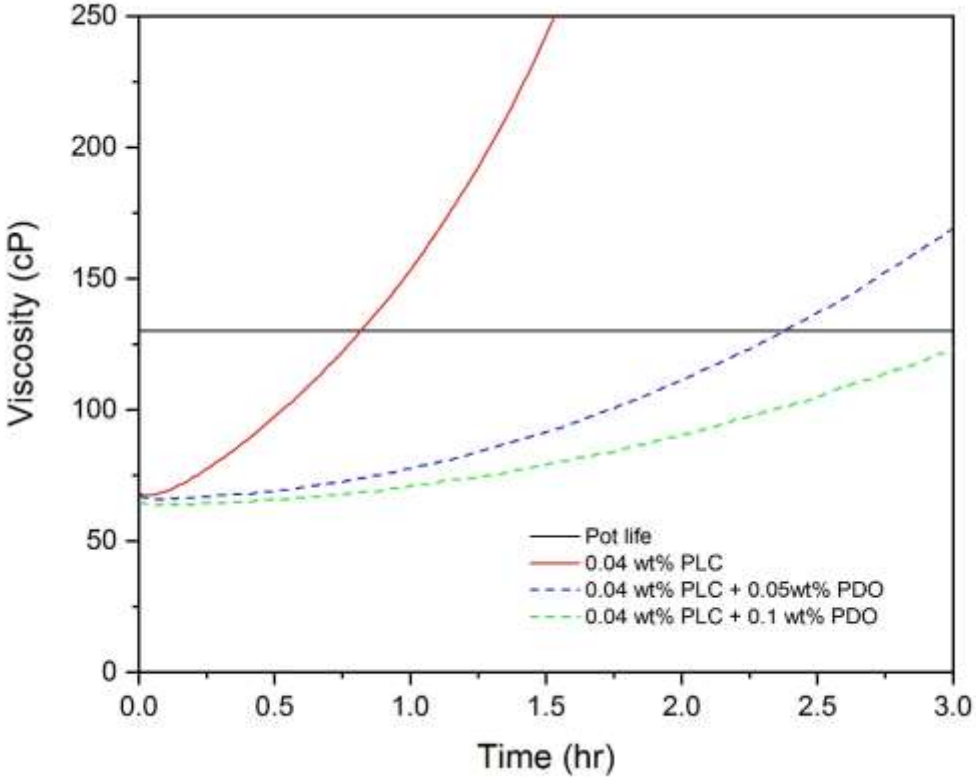
Drying performance

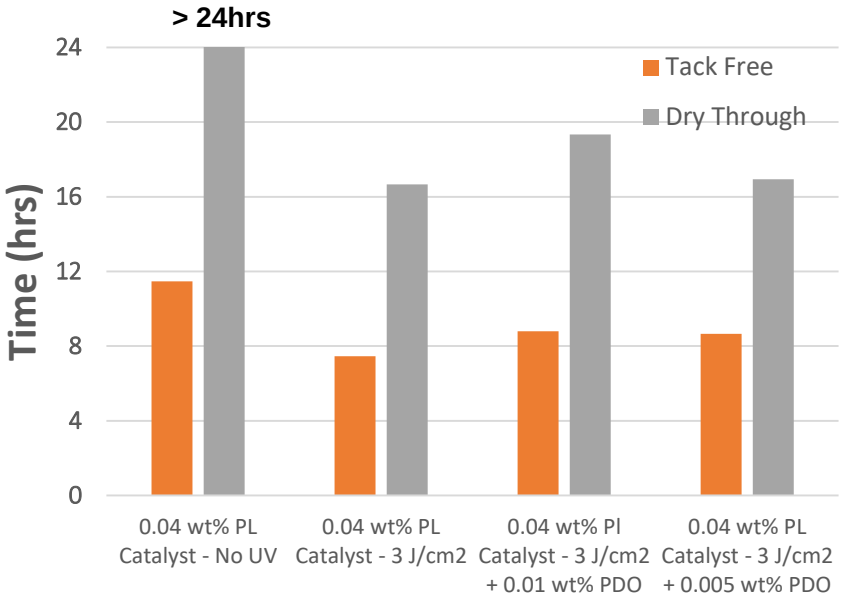


In order to make a fair comparison, equal pot life formulations were selected for this study.



Drying performance

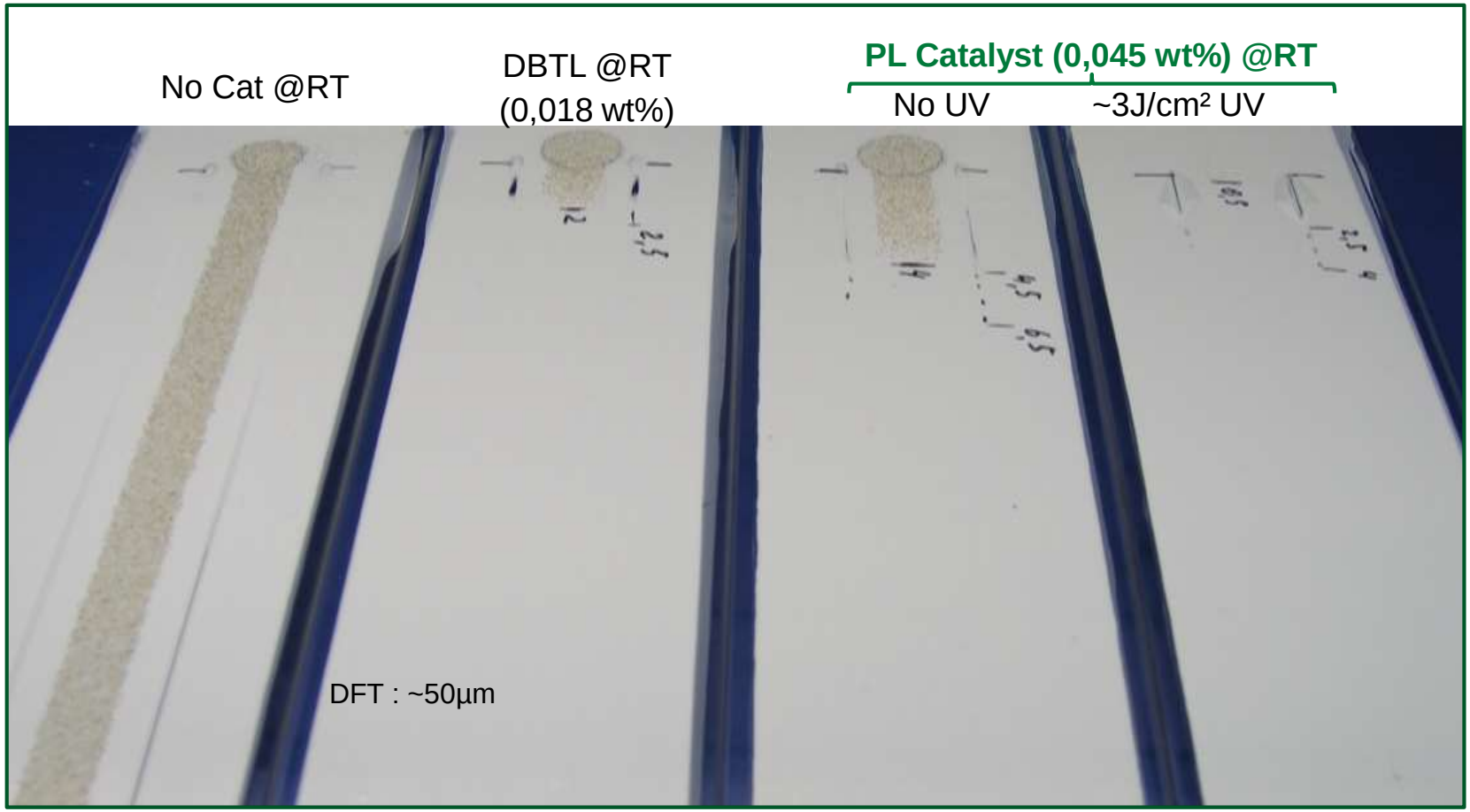




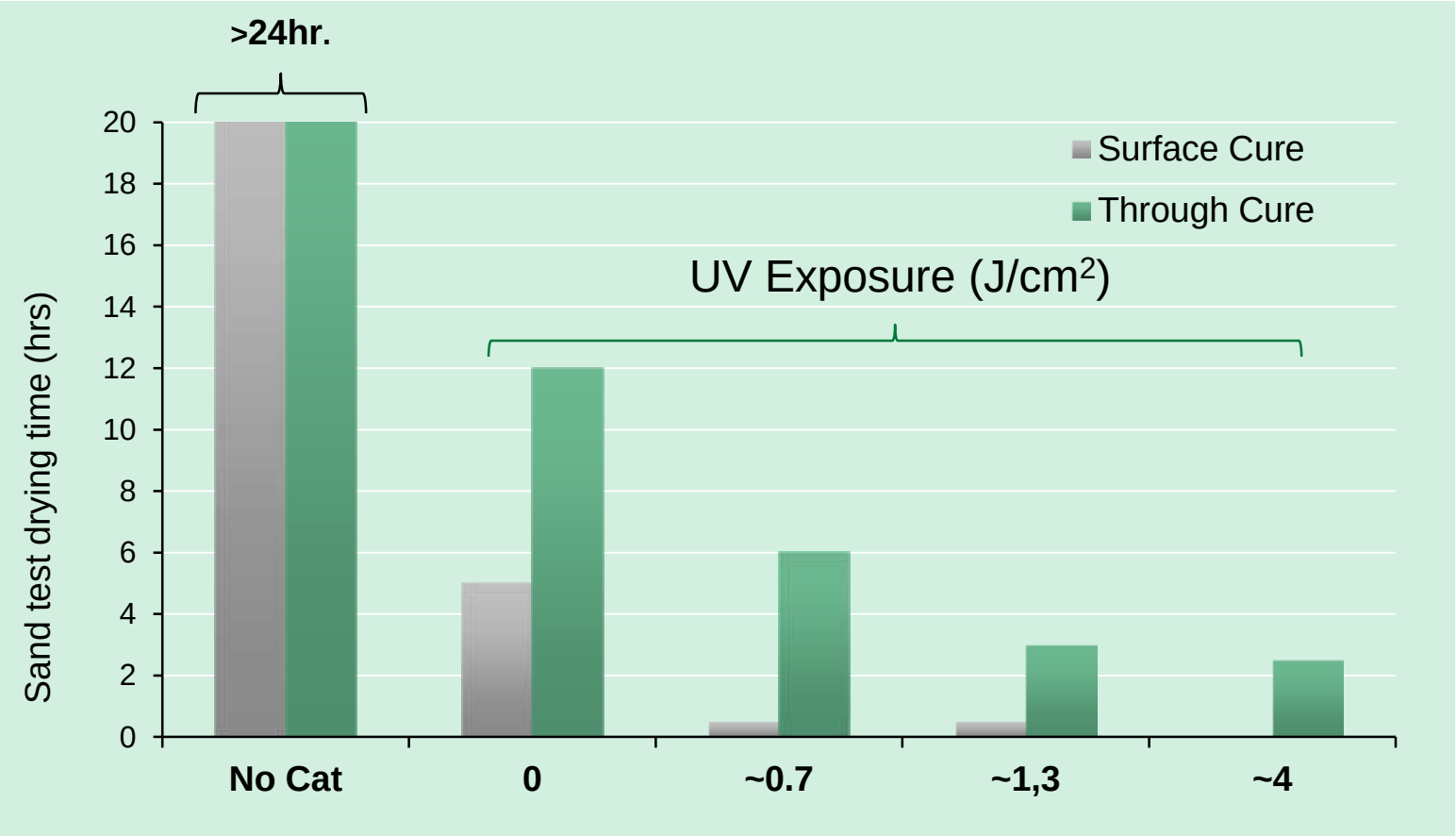
- PDO(2,4-pentanedione) can significantly increase the pot-life of 2K-PUR formulations.
- Photo-latent catalyst provides “cure on demand” property even with PDO.

Pigmented 2K-PUR coatings

- 2K-PUR white (~45wt.% TiO2 on resin solids)
- Drying performance was evaluated by sand test



Influence of UV activation

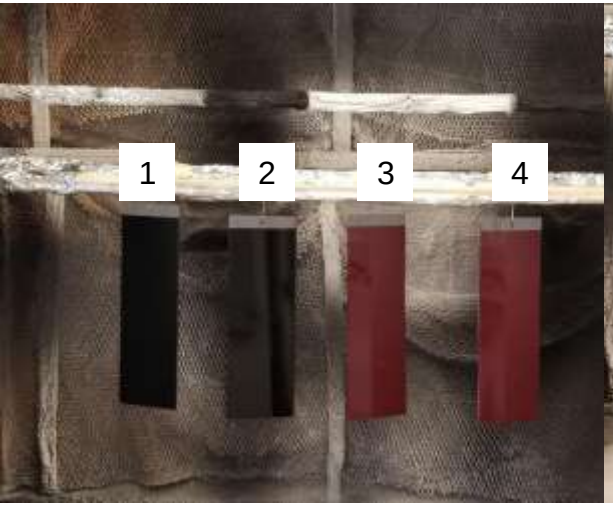


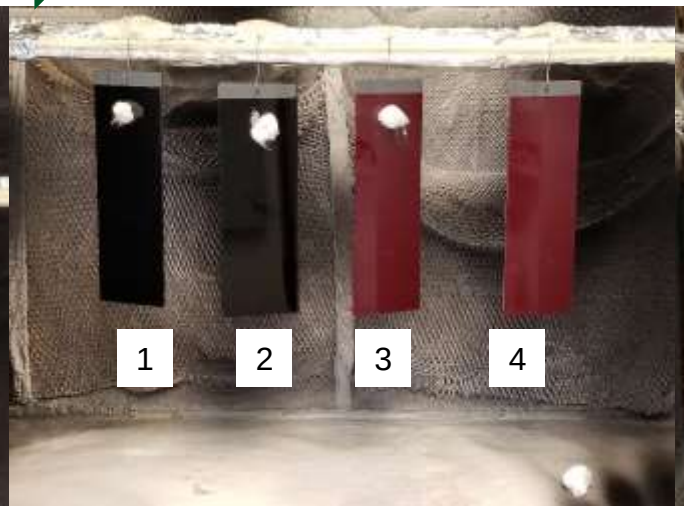
Field trial

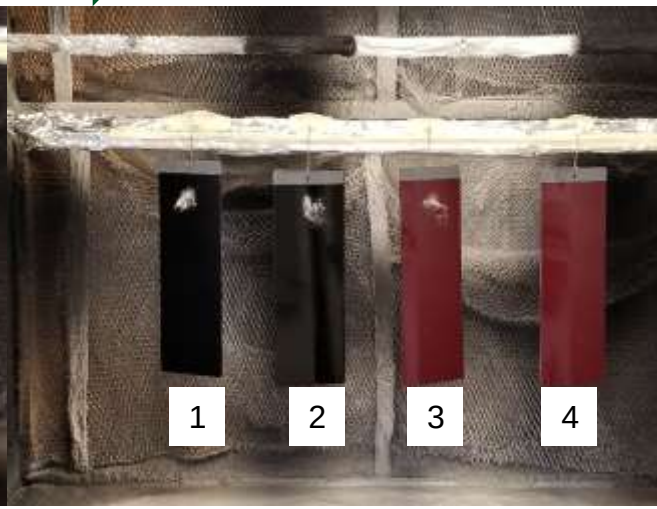
2K PUR clear coatings were applied on top of colored base coat.

1: 0.01 wt% DBTDL
2: 0.01 wt% DBTDL 3J/cm^2
3: 0.08 wt% PL Catalyst No UV
4: 0.08 wt% PL Catalyst 3J/cm^2

Apply Coating. DFT: 1.2 mil → Apply Cotton Ball after 1 hour → Peel off Cotton Ball







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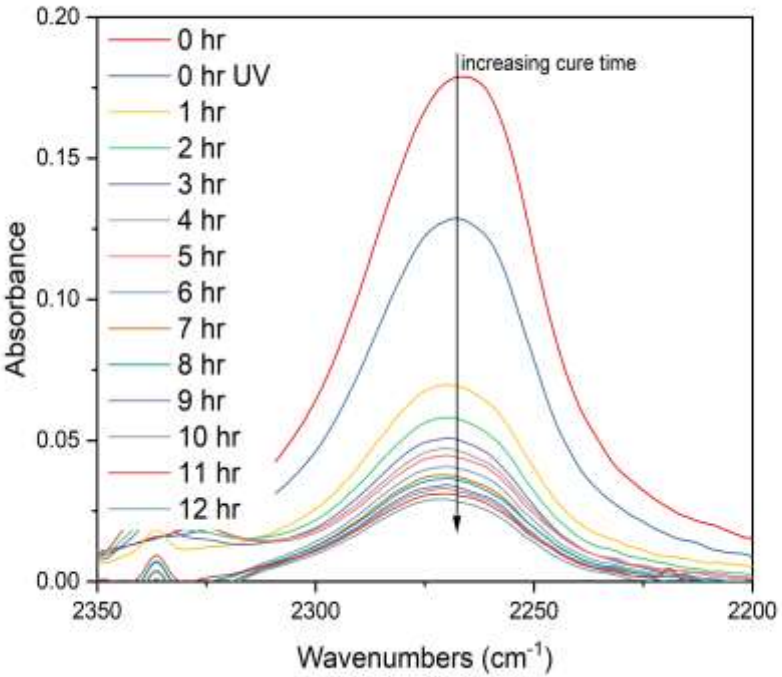
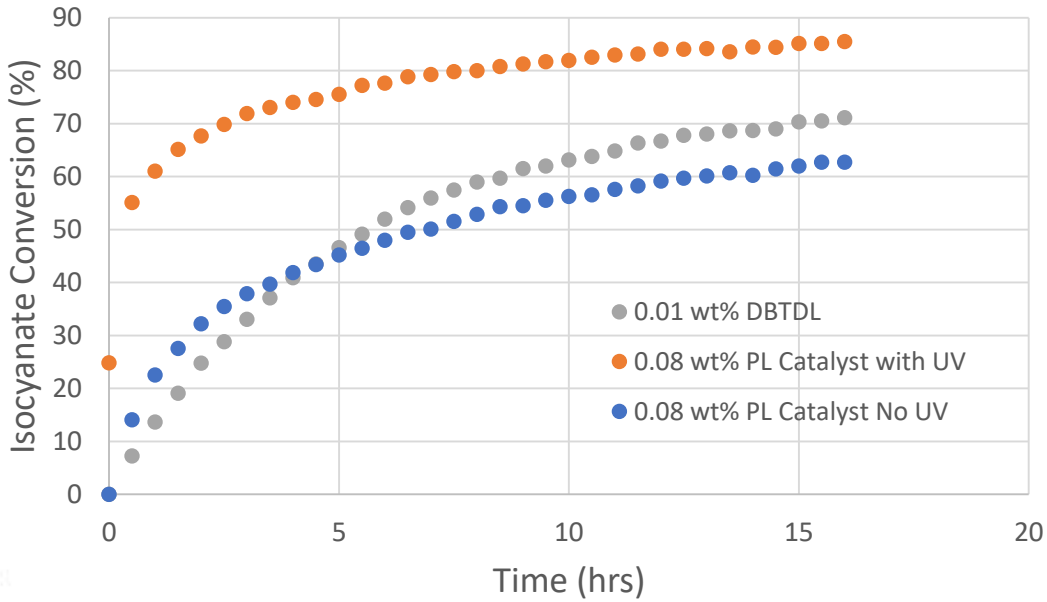
Measuring NCO concentration with FTIR

0.08% PL Catalyst + UV





- For the formulation with PL catalyst, 25% of Isocyanate was reacted immediately after UV light exposure.
- Reaction rate of UV exposed formulation was much higher than the others at first hour.

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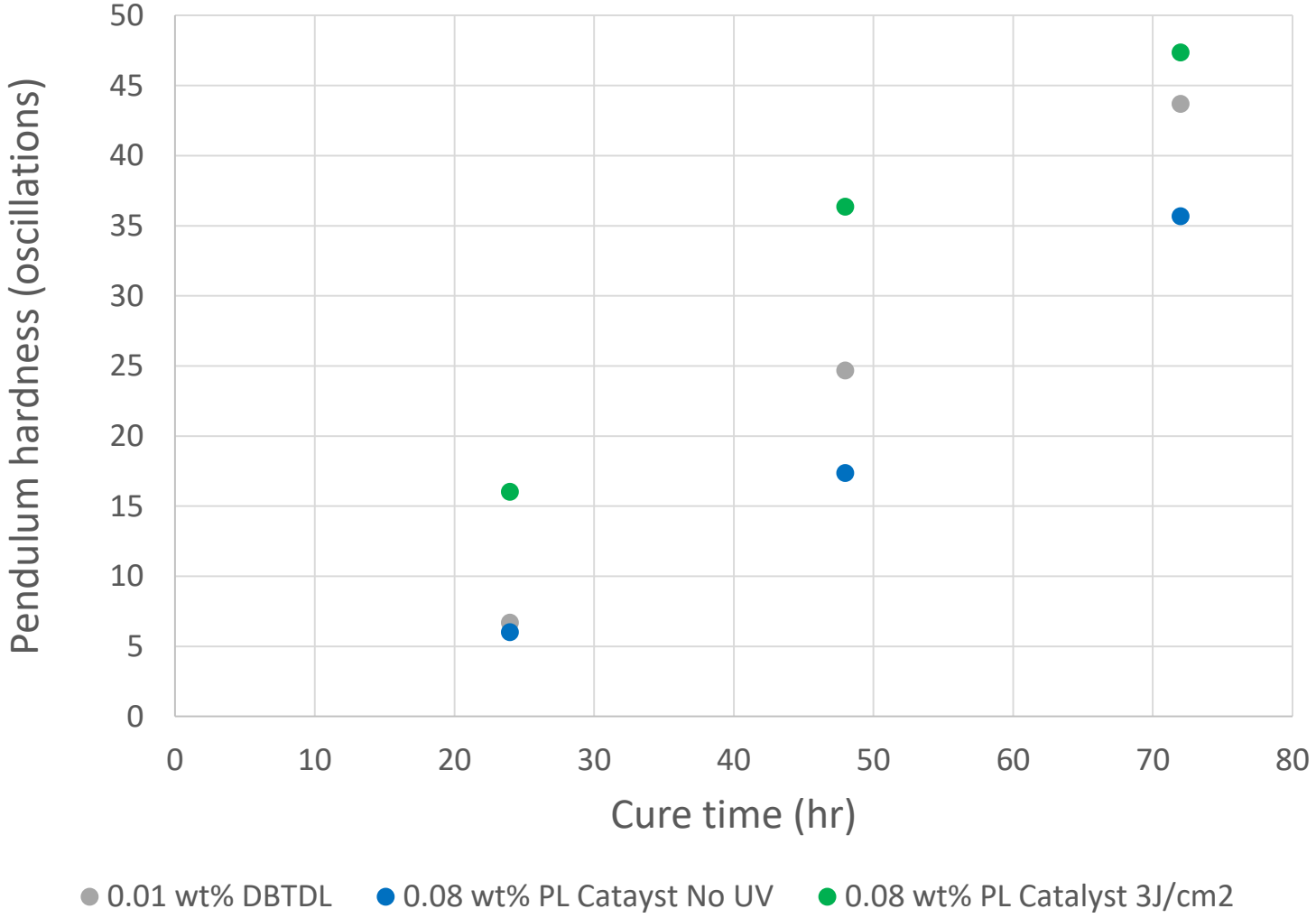
Hardness development



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Summary

- BASF Photo Latent Metal Catalyst is designed for curing 2K-PUR coatings, offering:
  - ✓ Fast curing--- Increase in through-put
  - ✓ Longer pot life--- Reduced waste
  - ✓ Room temperature, UV instead of heat & fast curing---Cost savings, e.g. lower energy, reduced floor and storage space, ...
  - ✓ Sn free---Healthier working environment

- BASF also offers Photo Latent Base Catalysts which can fit for different needs

- It exhibits high efficiency in both clear and pigmented coatings, including with difficult pigments for UV-curing systems, e.g. rutile-TiO_2, iron-oxides

- Add small addition of 2,4-pentanedione to 2K-PUR formula leads to extended pot-life without affecting the catalytic activity.

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