



Comprehensive stabilizer systems for Water-based Coatings

Steven Lee, Arvin Yang

Rianlon Corporation

Coatings Trends & Technologies

The Westin Lombard, Illinois

September 5, 2024

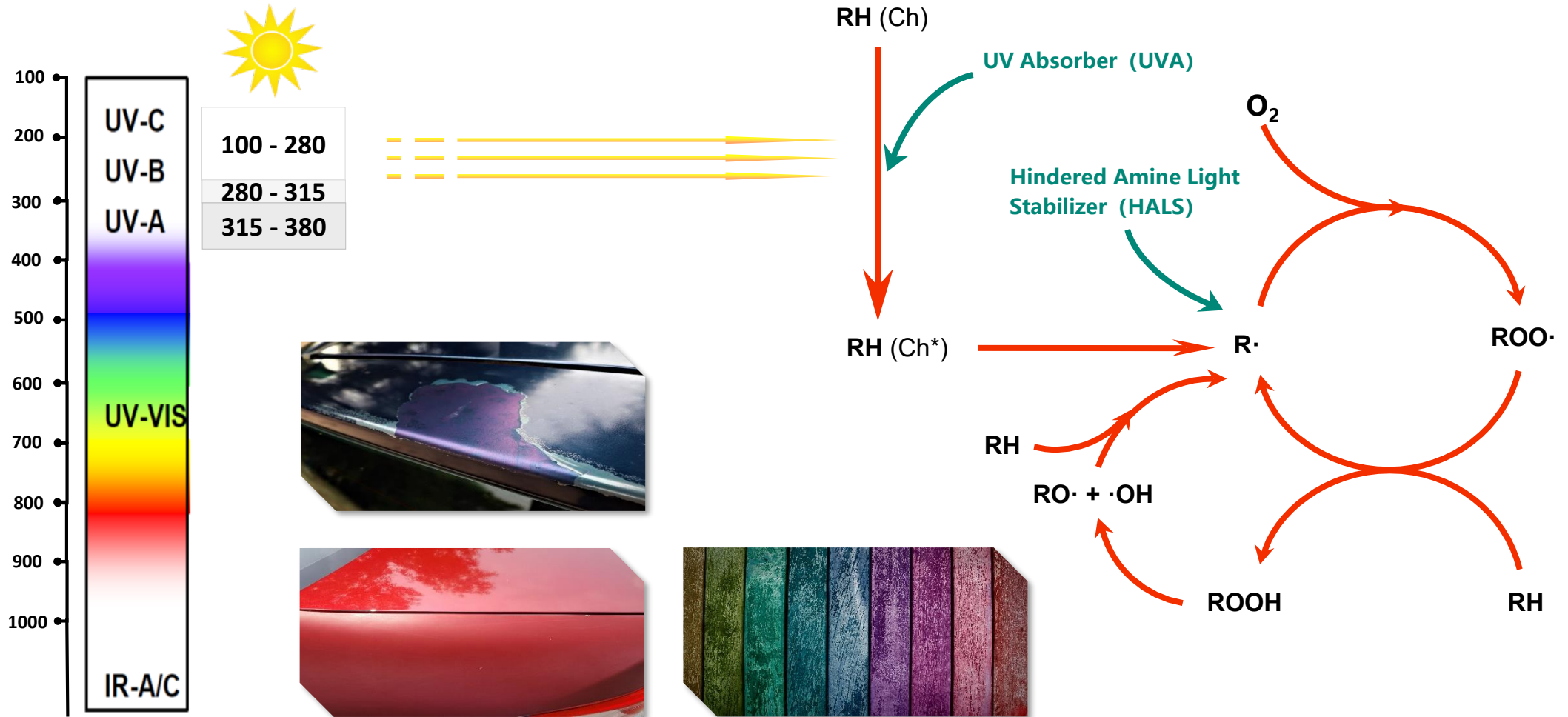
CONTENT

01 **Stabilization for coatings**

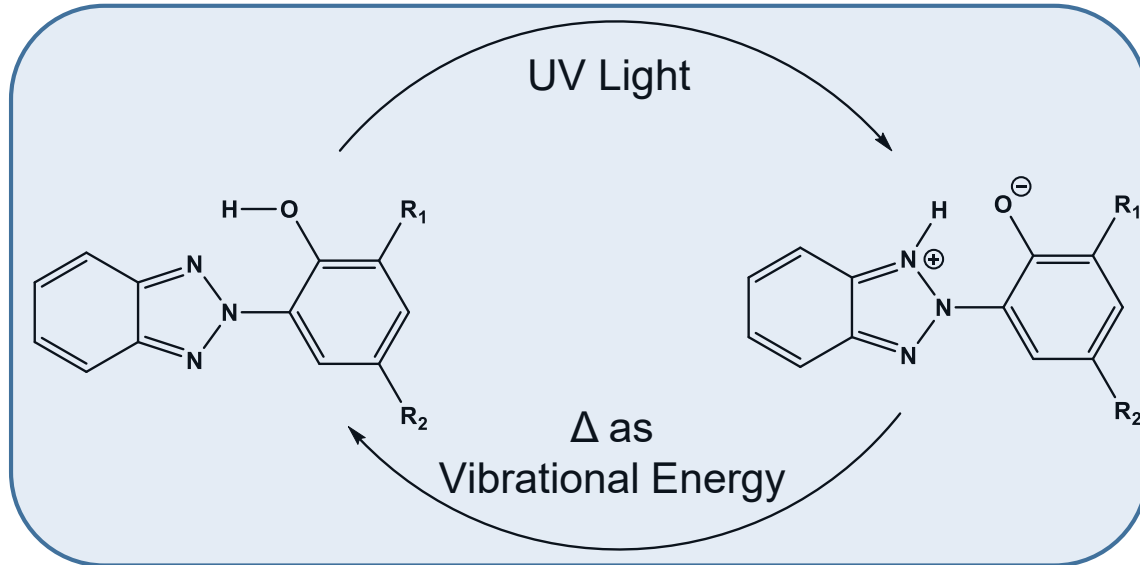
02 **Water-based reactable blend**

03 **Water-based technologies**

1.1 Solution of light stabilization

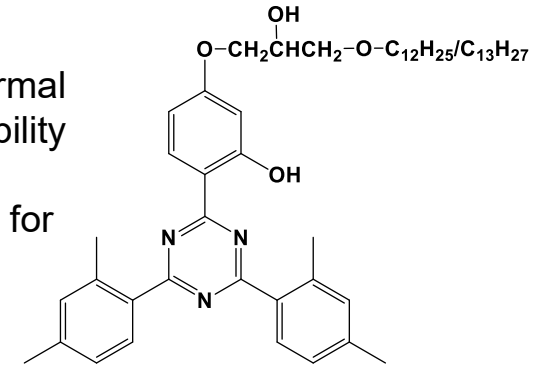


1.2 UV Absorbers (UVA)



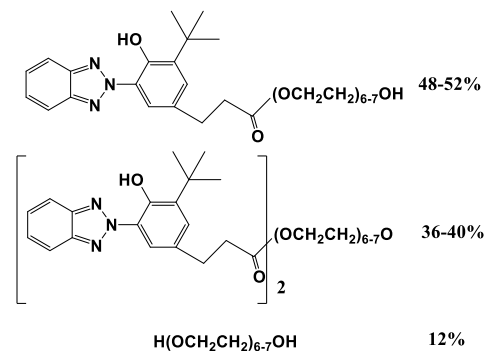
Traizine-1

- ◆ Provides very high thermal stability, high photostability and limited migration
- ◆ Especially recommend for applications need very high anti-weathering performance.



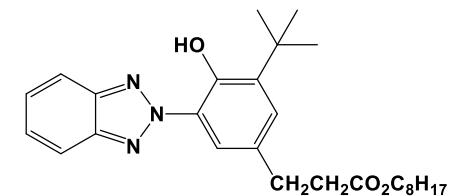
Benzotriazole-1

- ◆ Excellent photo-performance, can be easily incorporated into both solvent-borne and waterborne coatings.
- ◆ Suitable for wide range of coating applications.

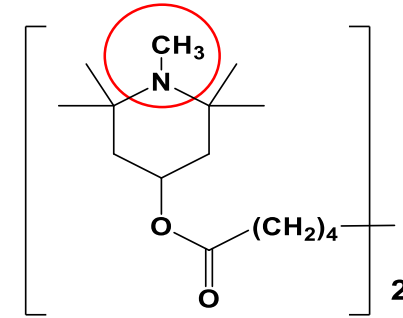
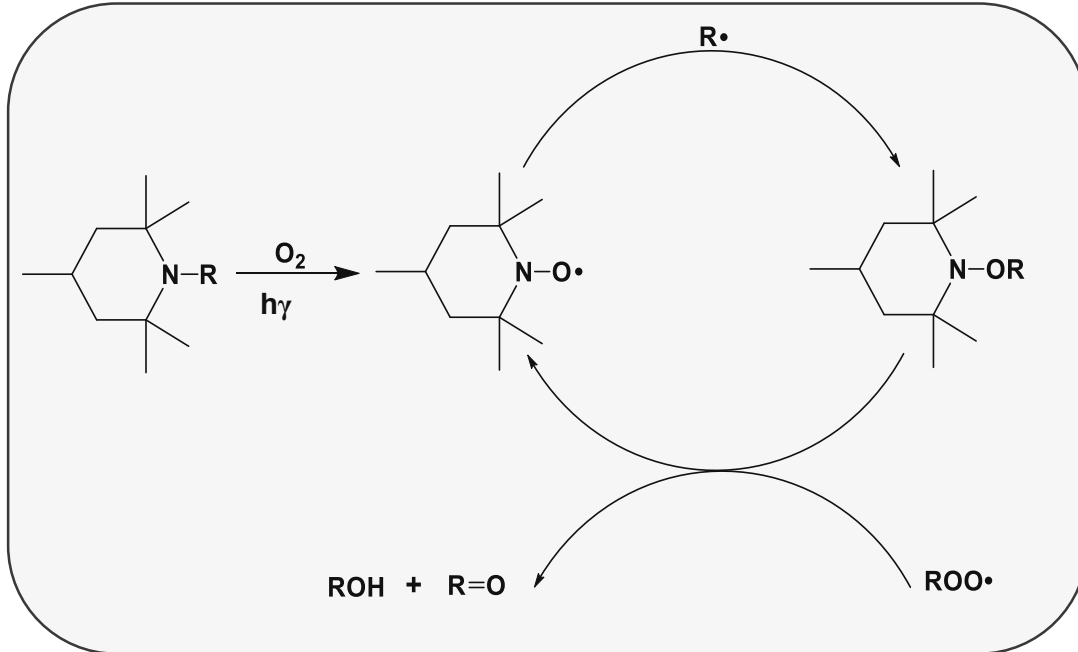


Benzotriazole-2

- ◆ Suitable for solvent-borne and specific waterborne coatings, which expose to high thermal and extreme environmental condition.

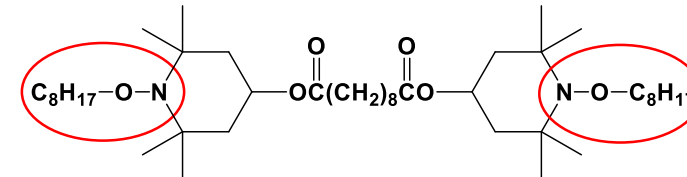


1.3 Hindered Amine Light Stabilizer (HALS)



HALS-1 (N-R type)

- Universal HALS for wide range of coatings.



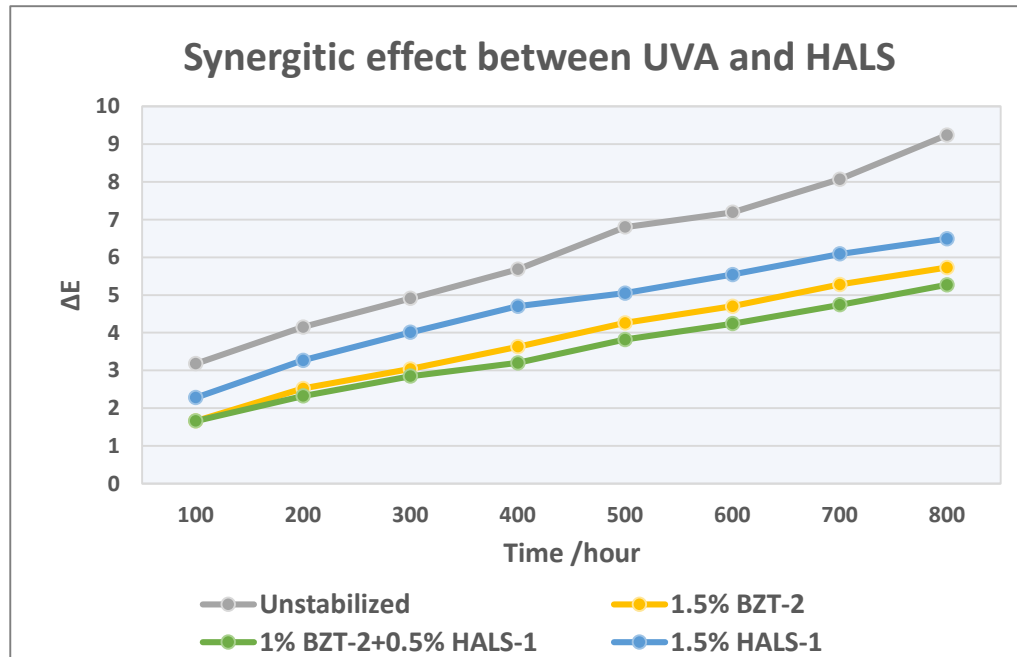
N-OR type HALS

- Low basic NOR HALS, recommended for coatings containing aggressive media such as acids, catalyst residues.

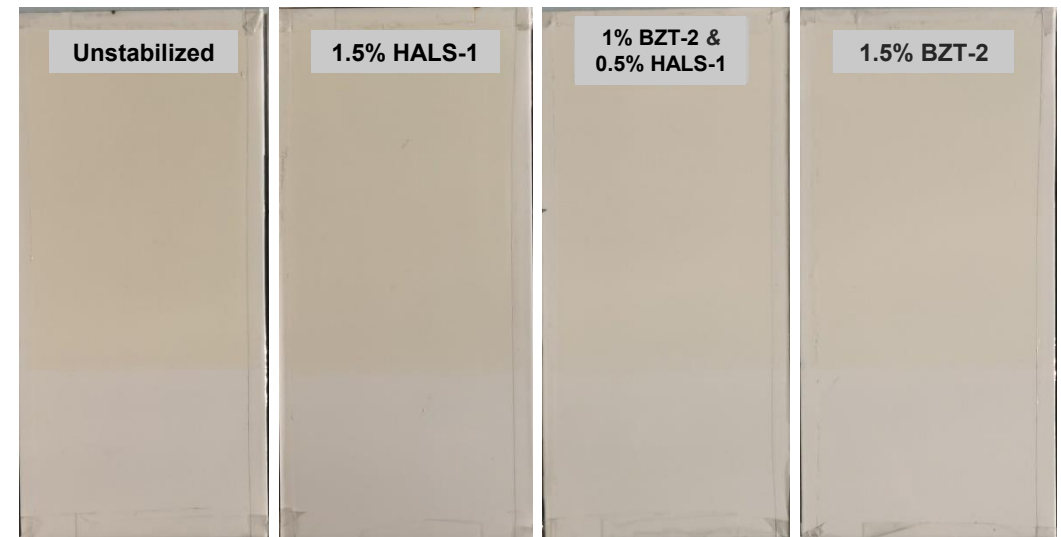
1.4 Synergistic effect of Light stabilizers

➤ Synergistic effect between UVA and HALS. Used in combination.

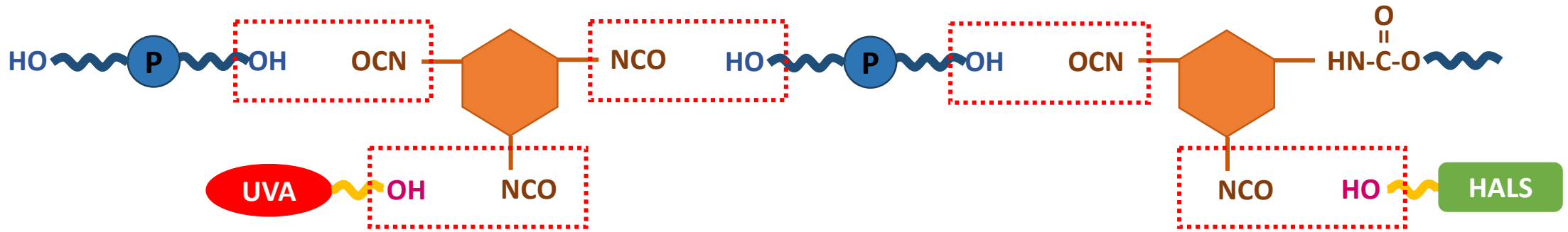
| Samples | Standard | Layer used | Substrate | Base coat | Clear coat | Thickness (BC/CC) | Application |
|----------------------------|---------------------------|------------|-----------|----------------------|----------------------------|-------------------|---------------------|
| UVA: BZT-2 HALS: HALS-1 | ASTM G 154-06, cycle 2 | Clearcoat | Steel | Solid white, Acrylic | 2K Acrylic polyurethane | 16 μ / 25-30 μ | Motorcycle coatings |



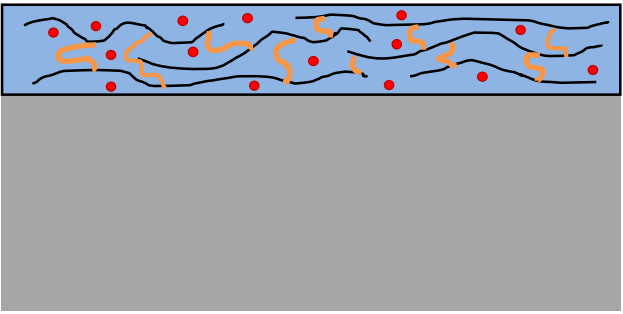
After 800 hours of QUV exposure:



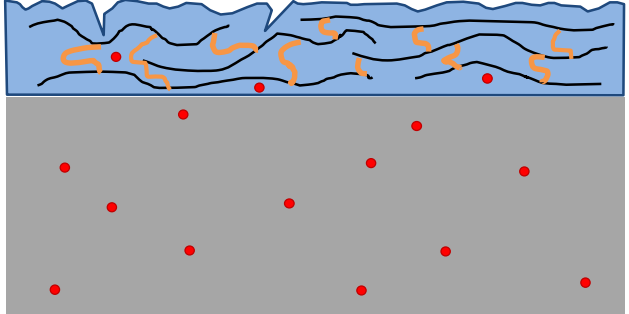
2.1 Reactable stabilizers



Conventional stabilizers

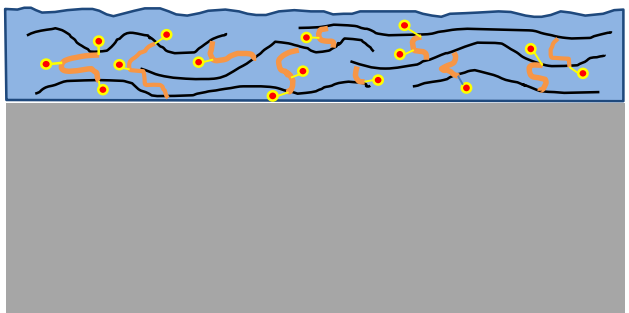
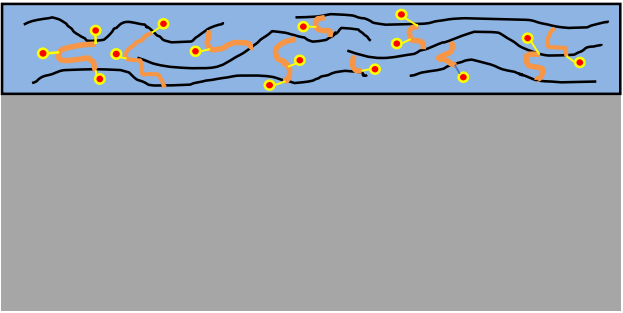


Long-term



weathering

Reactable stabilizers



2.2 Reaction with backbone resin

➤ Example: Reactable UVA in 2K PU clear-coat:

Description

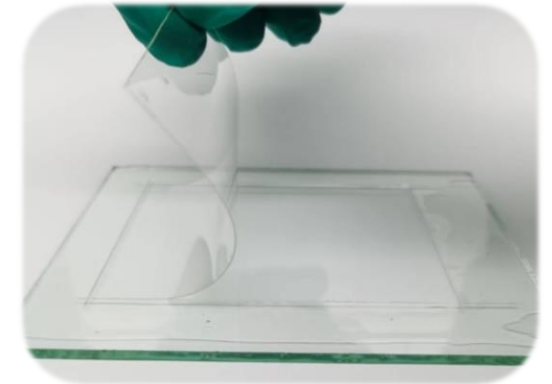
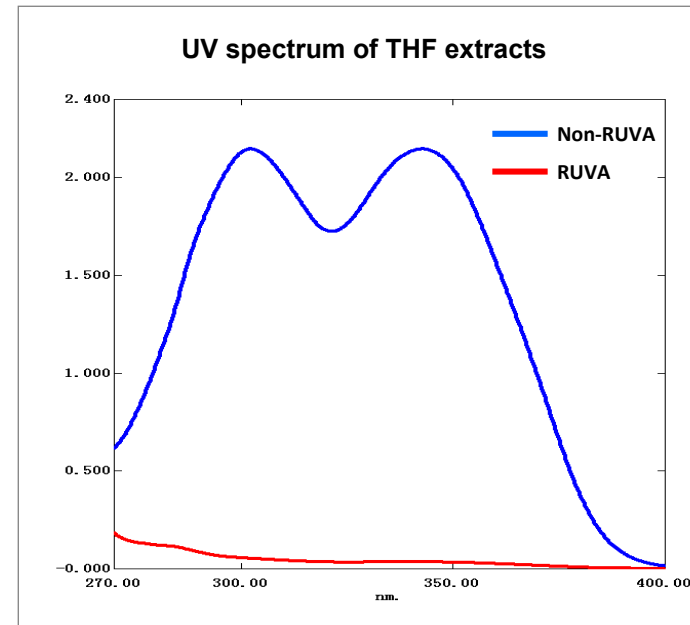
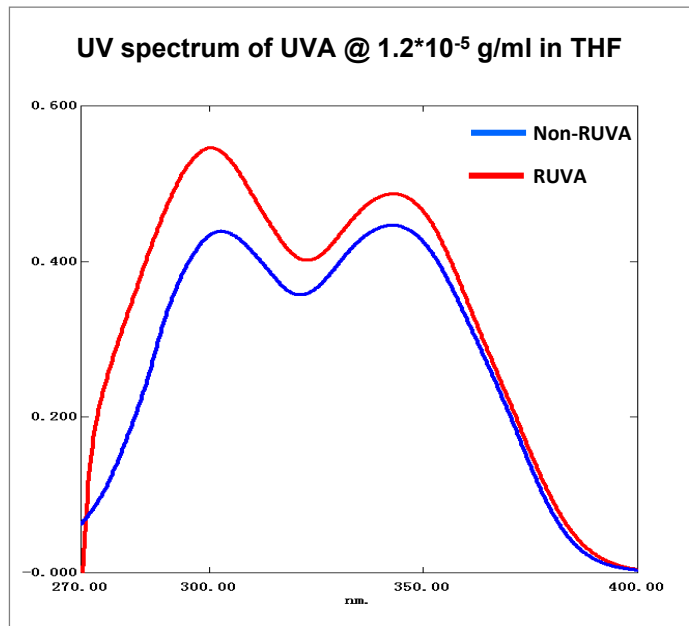
1. UV absorbers:

Non-RUVA: Conventional BZT UVA.

RUVA: BZT UVA with branched hydroxyl group (reactable group)

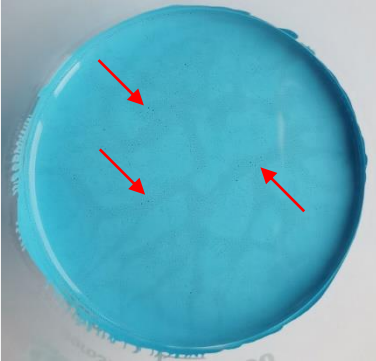



2. Experimental:

- (1) 1% UVAs added in 2K PU clear-coat.
- (2) Peeled the film off after bake.
- (3) Cured films were extracted by THF.



2.3 Compatibility in water

➤ Compatibility of WB reactalbe blend:

| | 1.5% reactable blend (UVA/HALS) | 2.2% WB version of reactable blend |
|---------------------------------|--|---|
| Initial |  |  |
| After 2 weeks of storage |  |  |

* For WB version of reactalbe blend, the active content is 66%(wt) .



Description

Matrix is main component of waterborne 2K Acrylic - Polyurethane coating for Automotive parts, blue solid topcoat.

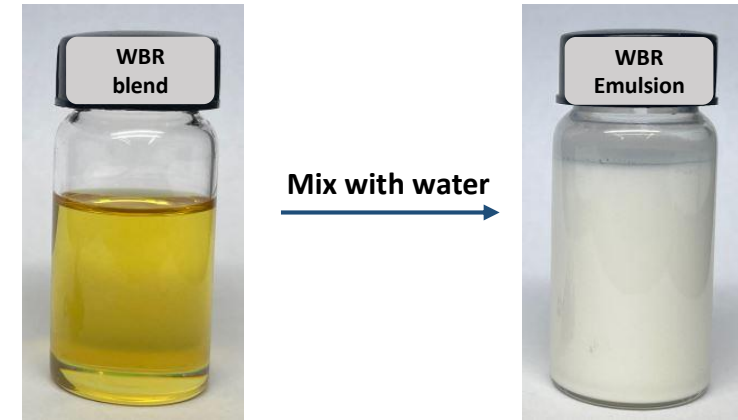
1. Reactable blend is mixed with WB coating under stirring.
2. WB reactable blend was premixed with water at 1: 5 (wt), to form a dispersion. Then add the dispersion into WB coatings with gentle stirring.

| | |
|------------------|--------------------|
| Solid content | 54 wt% |
| Water | 38-43 wt% |
| Co-solvents | 5~8 wt% |
| Stabilizer level | 1 % UVA & 0.5%HALS |

2.4 Waterborne reactable blend

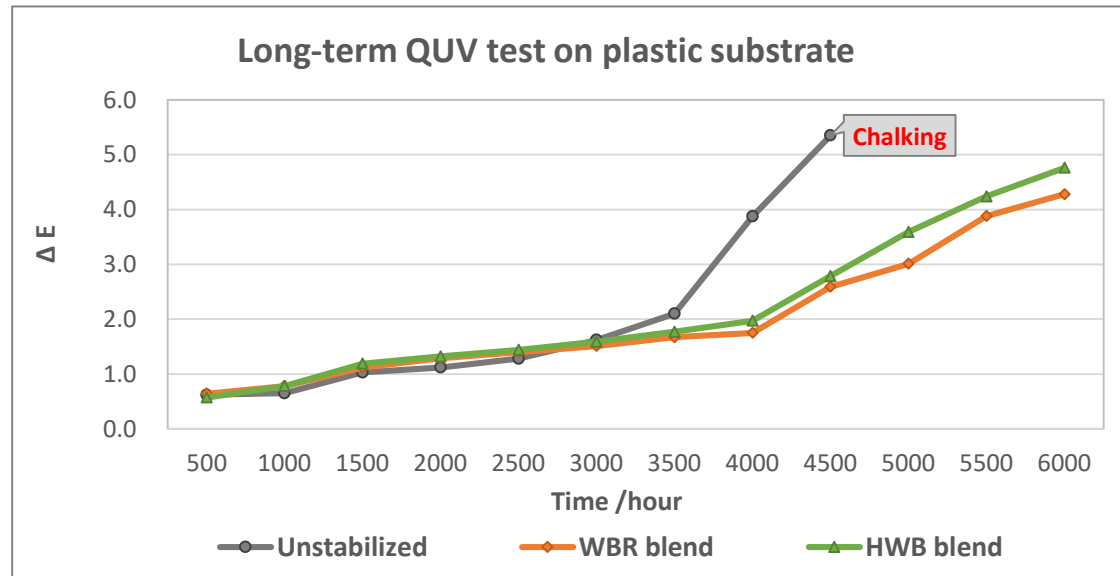
➤ Waterborne Reactable (WBR) blend

| Substrate | Standard | Layer used | Stabilizers |
|----------------------|-------------------------------|-------------------------|---|
| TPO | ASTM G154-06, cycle 1 (340nm) | Solid blue topcoat | 1% UVA & 0.5% HALS (on active content) |
| Primer 1 | Primer 2 | topcoat | Thickness (PS1 /PS2 /TC) |
| CPP modified Acrylic | 2K PU grey primer | 2K Acrylic-polyurethane | 6/ 25 /45 μ |



* Waterborne reactable blend (**WBR blend**), active components are reactable UVA and **reactable HALS**.

* High-performance WB blend (**HWB blend**), active components are reactable UVA and **UV-123**.



After Exposure:



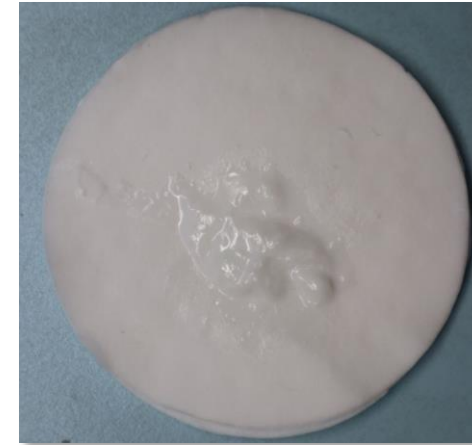
3.1 Compatibility of conventional stabilizers in water

- 3% of stabilizers in Acrylic modified dispersion:

Conventional UVA



After filtration



Water-based UVA

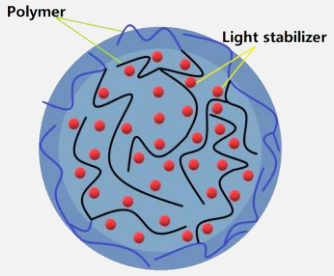
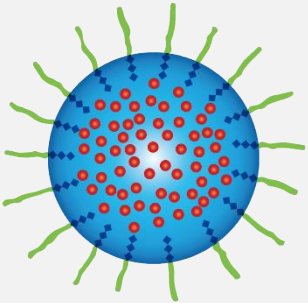


After filtration









3.2.1 Water-borne technologies

➤ Waterborne technologies applied in coating industry:

| Technology | Advantage | Limitation | | | | | |
|---|--|---|--|---|----------|---|---|
|  <p>Micro-encapsulation</p> | <ul style="list-style-type: none"> • Easy incorporation; • Excellent compatibility. | <ul style="list-style-type: none"> • Low active content. • Extra anti-freezing protection. • Short shelf life. | | | | | |
|  <p>Emulsifier assisted</p> | <table border="1"> <tr> <td data-bbox="606 778 904 1049">Blend</td> <td data-bbox="904 778 1584 1049"> <ul style="list-style-type: none"> • High active content. • Good freezing resistance. • Transportation and storage convenience. </td> <td data-bbox="1584 778 2313 1049"> <ul style="list-style-type: none"> • Works in most coating systems </td> </tr> <tr> <td data-bbox="606 1049 904 1249">Emulsion</td> <td data-bbox="904 1049 1584 1249"> <ul style="list-style-type: none"> • Easy incorporation; • Moderate active content. </td> <td data-bbox="1584 1049 2313 1249"> <ul style="list-style-type: none"> • Works in most coating systems • Extra anti-freezing protection. • Short shelf life. </td> </tr> </table> | Blend | <ul style="list-style-type: none"> • High active content. • Good freezing resistance. • Transportation and storage convenience. | <ul style="list-style-type: none"> • Works in most coating systems | Emulsion | <ul style="list-style-type: none"> • Easy incorporation; • Moderate active content. | <ul style="list-style-type: none"> • Works in most coating systems • Extra anti-freezing protection. • Short shelf life. |
| Blend | <ul style="list-style-type: none"> • High active content. • Good freezing resistance. • Transportation and storage convenience. | <ul style="list-style-type: none"> • Works in most coating systems | | | | | |
| Emulsion | <ul style="list-style-type: none"> • Easy incorporation; • Moderate active content. | <ul style="list-style-type: none"> • Works in most coating systems • Extra anti-freezing protection. • Short shelf life. | | | | | |







3.2.2 Anti-freezing performance (1)

➤ Waterborne UVA stored at -7 °C for a week:

| | Micro-encapsulation of UVA | Emulsion of UVA | Waterborne blend of UVA |
|-----------------------|--|---|---|
| Just after storage |  A clear glass vial with a black cap containing a thick, uniform, off-white cream. |  A clear glass vial with a black cap containing a thick, uniform, off-white cream. |  A clear glass vial with a black cap containing a thick, uniform, yellowish cream. |
| 4 hours after storage |  A clear glass vial with a black cap containing a thick, uniform, off-white cream, similar to the 'Just after storage' state. |  A clear glass vial with a black cap containing a thick, uniform, off-white cream, similar to the 'Just after storage' state. |  A clear glass vial with a black cap containing a clear, yellowish liquid, showing significant separation from the initial state. |

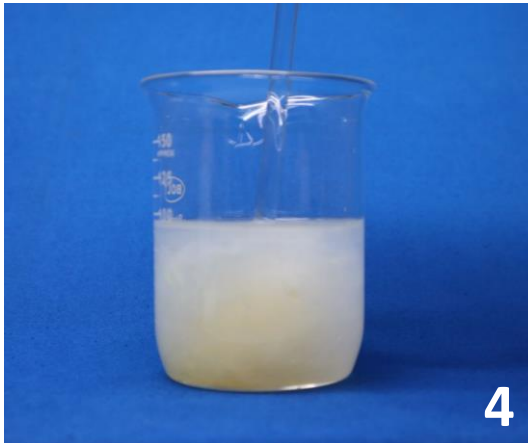
3.2.3 Anti-freezing performance (2)

➤ Waterborne HALS stored at -7 °C for a week:

| | Micro-encapsulation of HALS | Emulsion of HALS | Waterborne blend of HALS |
|-----------------------|--|--|---|
| Just after storage |  A clear glass vial with a black cap, containing a white, opaque, thick liquid at the bottom. |  A clear glass vial with a black cap, containing a white, opaque, thick liquid at the bottom, with some yellowish residue on the inner wall. |  A clear glass vial with a black cap, containing a clear, yellowish liquid at the bottom. |
| 4 hours after storage |  A clear glass vial with a black cap, containing a white, opaque, thick liquid at the bottom. |  A clear glass vial with a black cap, containing a white, opaque, thick liquid at the bottom, with some yellowish residue on the inner wall. |  A clear glass vial with a black cap, containing a clear, yellowish liquid at the bottom. |

















3.3.1 Waterborne blend

➤ Easy dispersion in water:



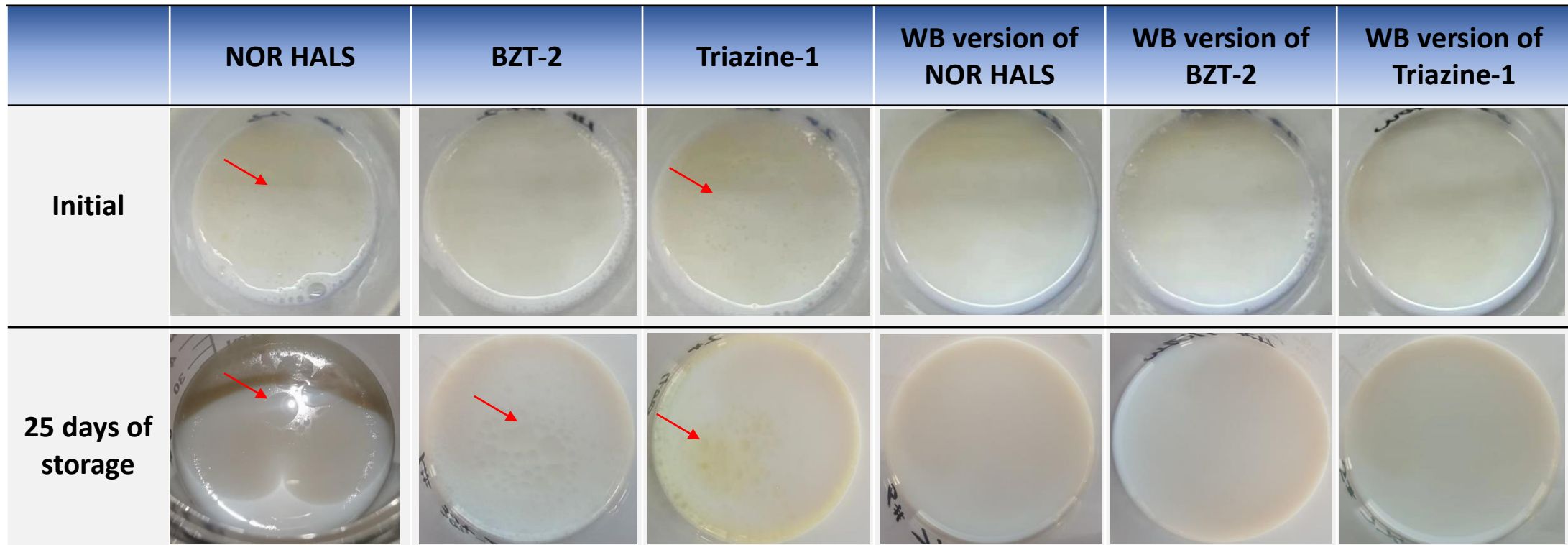
3.3.2 Waterborne series

➤ Waterborne products for WB coatings:

| Active component | Antioxidant | Triazine-1 | HPT UVA & NOR HALS | BZT-1 | BZT UVA & HALS | N-R HALS | NOR HALS | BZT-2 |
|------------------------|--|--|---|--|--|--|--|--|
| Appearance |  |  |  |  |  |  |  |  |
| Mixed with water (1:6) |  |  |  |  |  |  |  |  |

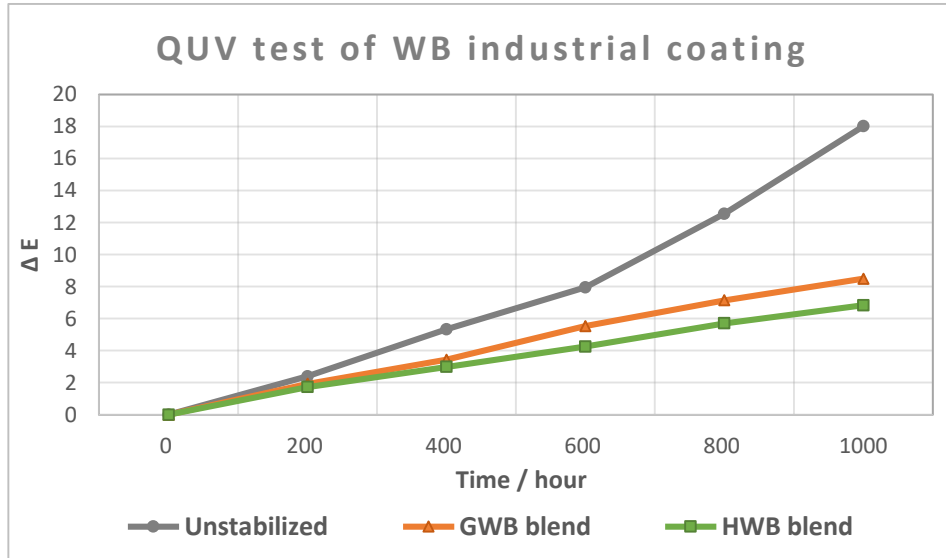
3.3.3 Compatibility test

- Test materials: Matrix is water-borne Polyurethane dispersion for industrial coatings. (Solid content is 50%wt, VOC \leq 1%)
- Test method: Add 1.5%wt (active content) into dispersion and form homogeneous mixtures. All mixtures are stored at room temperature.



3.4.1 General Waterborne blend (GWB blend)

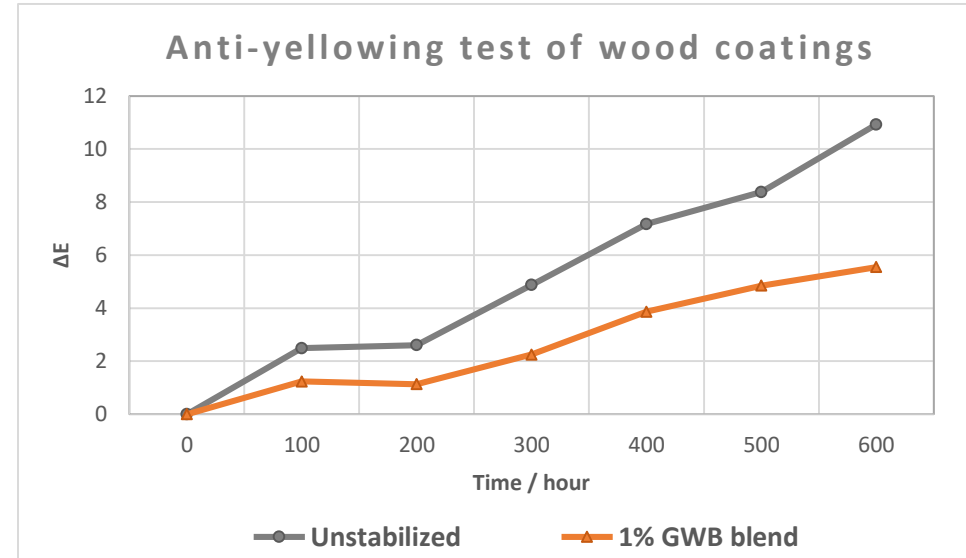
➤ WB industrial coatings



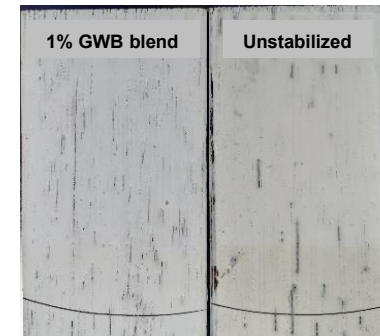
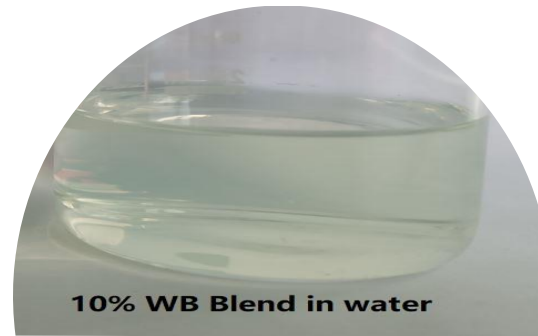
* Matrix is WB industrial coatings. Loading level of stabilizers is 1% (on active content).
 * QUV test reference: ASTM G154-06, cycle 2



➤ WB wood coatings



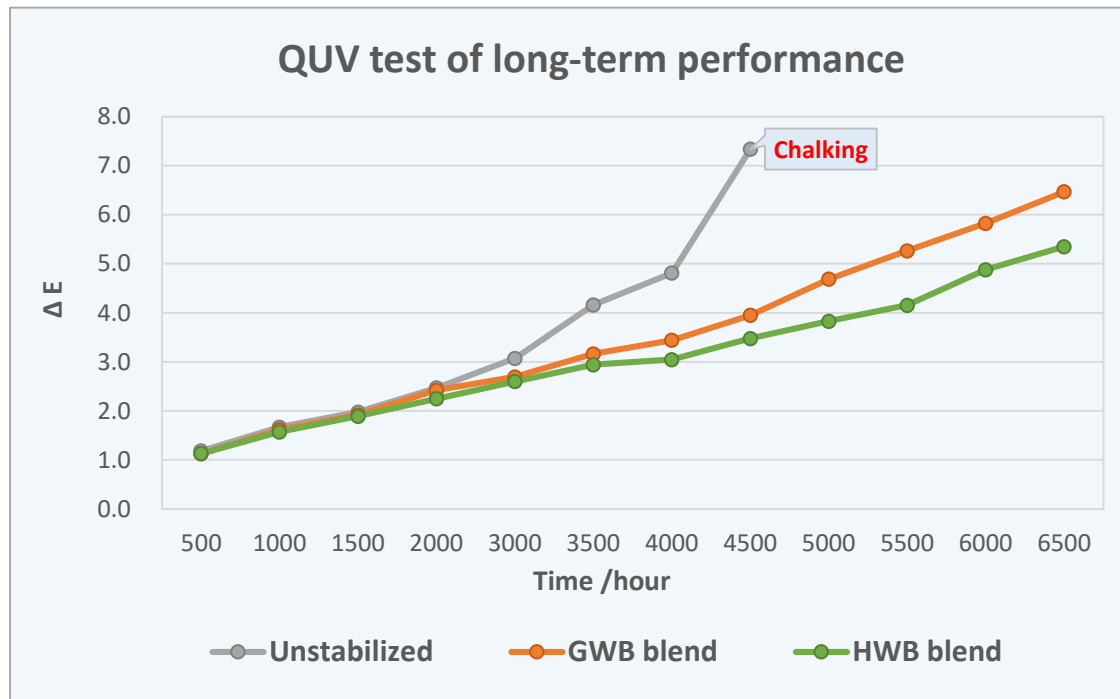
* Matrix is WB wood coatings. Backbone resin is acrylic.
 * QUV-A test. BPT: 60±3 °C. 0.68 W/m² at 340nm. 168 hours.



3.4.2 High-performance WB blend

➤ High-performance WB blend (HWB blend)

| Substrate | Standard | Layer used | Stabilizers | Primer 1 | Primer 2 | topcoat | Thickness (PS1 /PS2 /TC) |
|------------|-------------------------------|--------------------|-----------------------|----------------------|-------------------|-------------------------|--------------------------|
| TPO panels | ASTM G154-06, cycle 1 (340nm) | Solid blue topcoat | 1.5% active component | CPP modified Acrylic | 2K PU grey primer | 2K Acrylic-polyurethane | 6/ 25 /45 μ |



After exposure



3.5 Water-based Anti-oxidant



Description

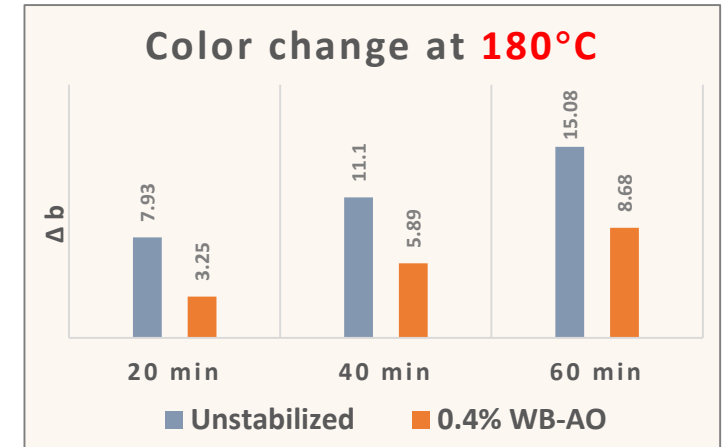
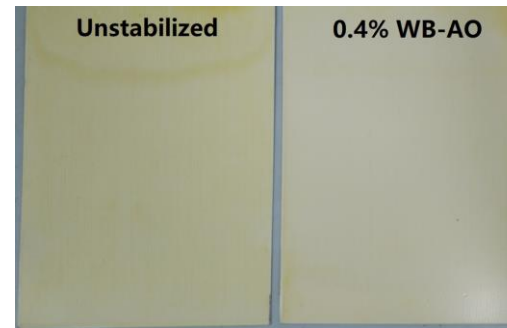
➤ Test materials:

- (1) Prepare a 2K WB clear-coat with WB polyurethane dispersion as backbone resin.
- (2) Add 4‰ (on formula) **WB anti-oxidant (WB-AO)** into 2K WB clear-coat.
- (3) Before application, clear-coat mix with hardener at NCO:OH= 1.1 : 1
- (4) All clear-coats applied on the same white substrates. Wet thickness is 150 microns. Dry film thickness is 60 microns.

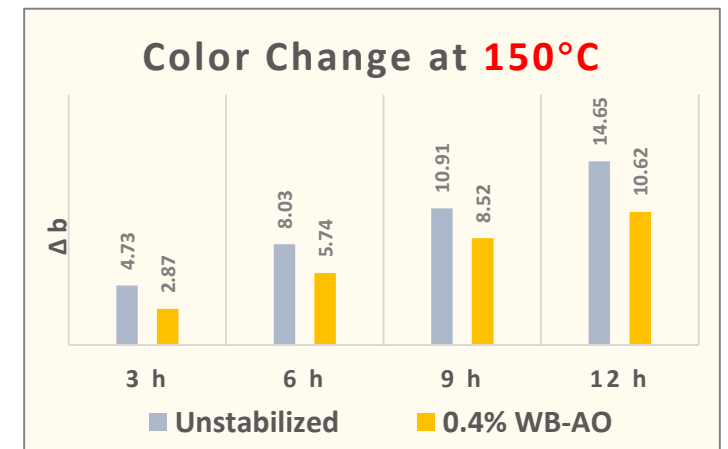
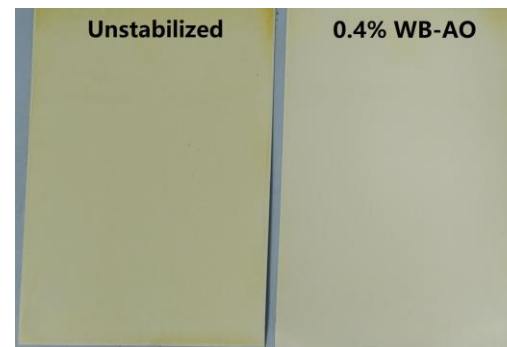
➤ Test methods:

- (1) All cured panels are placed in oven at 150°C or 180°C.
- (2) Test color change with colorimeter (X-rite)

• 60 min at 180 °C:



• 12 hours at 150 °C:



Anti-aging solutions for coatings

Primary Antioxidant

Secondary Antioxidant

*High-performance
blend*

*Water-based
products*

UV absorber

*Hindered Amine
Light stabilizer*

Comprehensive stabilizer systems for Water-based Coatings

Acknowledgements

Dr. Ravi Ravichandran (Technical support, Amindon)

Dr. Miles Hutchings (Technical support, Amindon)

Thanks for your attention

Contact us:

steven.lee@rianlon.com

Please visit our website: www.rianlon.com

See you at Rianlon 's Tabletop #39