Clariant Light & Heat Stabilizers Additives for Coatings

September 2016
Agenda

- Overview Coatings Light Stabilization
- Clariant Unique Light & Heat Stabilizers Solutions for
  1. Solventborne
  2. Waterborne
  3. UV
  4. Powder
  5. Offset Products
Degradation of coatings under UV light exposure

Stabilization possibilities

1. UV Absorbers Additives
   Principle: absorption (filter effect) of damaging UV light
   *(coating thickness and dosage dependent – Beer Lambert principle)*
   Suggested dosage:
   - Clearcoat: from 1.0% to 2.5%
   - Monocoat pigmented: none to 1.0%

2. Radical Scavengers (HALS) Additives
   Principle: trapping of radicals before further propagation reactions leading to degradation
   Suggested dosage:
   - Clearcoat: from 0.5% to 1.0%
   - Monocoat pigmented: from 0.5% to 1.0%
UV Absorbers – Mechanisms of stabilization

- There are 4 main classes of UV Absorbers commonly used in coatings

<table>
<thead>
<tr>
<th>Class</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzophenones</td>
<td>- Low cost</td>
<td>- Poor weathering due to photo-permanence</td>
</tr>
<tr>
<td></td>
<td>- Moderate weathering</td>
<td>- Weathering (moderate)</td>
</tr>
<tr>
<td></td>
<td>- Low in-can color</td>
<td>- Absorbance profile (limited)</td>
</tr>
<tr>
<td></td>
<td>- No discoloration with metallic ions</td>
<td>Disadvantage - Color</td>
</tr>
<tr>
<td></td>
<td>- Good for QUV specifications</td>
<td>- Discoloration with metal ions</td>
</tr>
<tr>
<td>Oxalanilides</td>
<td>- Good weathering</td>
<td>- Highest cost</td>
</tr>
<tr>
<td></td>
<td>- Good absorbance</td>
<td></td>
</tr>
<tr>
<td>Triazines</td>
<td>- Excellent weathering</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Good absorbance</td>
<td></td>
</tr>
<tr>
<td>Benzotriazoles</td>
<td>- Weathering (moderate)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Absorbance profile (limited)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Lowest cost</td>
<td></td>
</tr>
</tbody>
</table>

Mechanisms of stabilization:

- There are 4 main classes of UV Absorbers commonly used in coatings.

Benzophenones:
- Low cost
- Moderate weathering
- Low in-can color
- No discoloration with metallic ions
- Good for QUV specifications
- Poor weathering due to photo-permanence

Oxalanilides:
- Good weathering
- Good absorbance

Benzotriazoles:
- Excellent weathering
- Good absorbance

Triazines:
- Lowest cost
UV Absorbers – Mechanisms of Stabilization

- Comparison of different UV absorbers

![Graph showing absorption of UV absorbers across different wavelengths.](image_url)
Radical Scavengers (HALS) – Mechanisms of Stabilization

– Hindered Amine (Light) Stabilizers – HALS

\[
\begin{align*}
R' & \quad R'' \\
\text{tetra-methyl-piperidine}
\end{align*}
\]

\[
R = \begin{cases} 
- \text{H} & \text{not substituted} \\
- \text{CH}_3 & \text{methylated} \\
- \text{O} - \text{R}' & \text{etherified} \\
- \text{C} - \text{CH}_3 & \text{acylated}
\end{cases}
\]

R’ and R” control secondary properties (e.g. compatibility, solubility, volatility etc.)

Selection factor: pH (basic, non-basic), liq/solid, compatibility, migration, cost
Offset Products
Offset light stabilizers for coatings

**HALS:** Hostavin 3065 liq.
- OFFSET OF TINUVIN 292

**UVA:**
- Hostavin 3311 LIQ
- OFFSET OF TINUVIN 1130
- Hostavin 3340 LIQ
- OFFSET OF TINUVIN 400
- Hostavin 3310 PWD
- OFFSET OF TINUVIN 328
- Hostavin 3326 PWD
- OFFSET OF TINUVIN 326
Novel Light Stabilizers Additives for High Performance Waterborne & Solventborne Coatings

Public
Dr. Mouhcine Kanouni
BU Additives - Business Line Polymer Additives
Technical Marketing Coatings
July 2016

what is precious to you?
Unique Light stabilizers for solvenborne coatings

**Synergistic solution UV Absorber + HALS : HOSTAVIN TB 03**

- Hostavin TB-03 liq. is recommended in all kind of high performance coatings for applications such as:
  - automotive clearcoats
  - plastic coatings
  - high end wood coatings
- Compatible with both solventborne and waterborne coatings
- T.X free (toluene, xylene)
- Low color

**Classification**
- 1:1 mixture of triazine UV absorber + HALS
Unique Light stabilizers for solvenborne coatings

Synergistic solution UV Absorber + HALS : HOSTAVIN TB 04

- Hostavin TB-04 liq. is recommended for all kind of high performance coatings that require non-basic HALS and for applications such as:
  - automotive clearcoats (high crosslink epoxy or acid catalyzed)
  - plastic coatings
- Compatible with both solventborne and waterborne coatings
- T.X free (toluene, xylene)
- Low color

Classification
- 2:3 mixture of triazine UV absorber + non-basic HALS

Improvement over Hostavin TB 02
Light Stabilizers for Solventborne Coatings

Public
Dr. Mouhcine Kanouni
BU Additives - Business Line Polymer
Additives
Technical Marketing Coatings
July 2016

What is precious to you?
Unique Light stabilizers for solvenborne coatings

Synergistic solution UV Absorber + HALS: Hostavin 3212 Liq

- Cost competitive Light stabilizer for **Clearcoat** (2 part UVA OXA + 1 part HALS)
- Low In-can Yellow color for auto Refinish Market
- Superior performance in QUV up to 1500 hrs. for alkyd, acrylic and PU
- Good Performance in Xenon accelerated weathering (up to 2000 hrs.)
Unique Light stabilizers for solvenborne coatings

**HALS:** Hostavin 3068 liq.

- **Key benefits**
  - Non-basic HALS
  - High compatibility with broad range of resins (WB and SB)
  - Excellent performance for coatings on plastics

**HALS:** Hostavin 3070 PWD (formally Hostavin N 30P)

- **Key benefits**
  - Oligomeric HALS
  - Non-migrating, non-extractable, non-bleaching
  - Ideal for [Plastic Coatings](#) and [Monocoat Pigmented](#) coatings
  - Low tox. Profile
  - High heat stability
  - Slightly basic
# Product Portfolio Review
## Light Stabilizers for SB, UV and Powder Coatings

<table>
<thead>
<tr>
<th>Products</th>
<th>Value Proposition</th>
<th>Coating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UV Absorber</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOSTAVIN AR0 8</td>
<td>Most cost effective additive solution for light stability performance (Benzophenone)</td>
<td>✓</td>
</tr>
<tr>
<td>HOSTAVIN 3206 liq.</td>
<td>Good weathering, low in-can color, no discoloration with metallic ions, excellent for QUV specifications, non interacting during UV curing (Oxalanilide)</td>
<td>✓</td>
</tr>
<tr>
<td>HOSTAVIN VSU</td>
<td>Powder form, xylene free version of Hostavin 3206 (Oxalanilide)</td>
<td>✓</td>
</tr>
<tr>
<td>HOSTAVIN 3330 PWD</td>
<td>UV absorber for superior performance requirement (Triazine)</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Radical Scavenger (HALS)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOSTAVIN 3052 liq.</td>
<td>Graftable Radical Scavenger for Plastic Coatings</td>
<td>✓</td>
</tr>
<tr>
<td>HOSTAVIN 3068 liq.</td>
<td>Non-basic HALS with high compatibility, for plastic coatings &amp; non interacting during UV curing</td>
<td>✓</td>
</tr>
<tr>
<td>HOSTAVIN 3070 PWD</td>
<td>Cost competitive, Low migration, extraction polymeric HALS</td>
<td>✓</td>
</tr>
<tr>
<td>HOSTAVIN PR-31</td>
<td>Low migration photo-reactable HALS</td>
<td>✓</td>
</tr>
<tr>
<td><strong>UVA + HALS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOSTAVIN TB-01 liq.</td>
<td>Synergistic solution of high performing HPT and standard HALS for monocoatand Epoxy, Aromatic PU coatings (1 part Hostavin triazine + 1 part of Hostavin 3050)</td>
<td>✓</td>
</tr>
<tr>
<td>HOSTAVIN TB-02 liq.</td>
<td>Synergistic solution of high performing HPT + non-basic HALS (2 part Hostavin triazine + 3 part of Hostavin 3058)</td>
<td>✓</td>
</tr>
</tbody>
</table>
Light Stabilizers for Waterborne Coatings

Dr. Jean Yves Desrats & Mouhcine Kanouni
BU Additives - Business Line Polymer Additives
Technical Marketing Coatings
July 2014
## Light Stabilizers Additives for Waterborne Coatings

### Available options for UV absorbers and radical scavengers

<table>
<thead>
<tr>
<th></th>
<th>100% Active liquid</th>
<th>Solid form</th>
<th>Waterbased (proprietary)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incorporation to coating</strong></td>
<td>Partially compatible</td>
<td>not compatible</td>
<td>Dispersion *52% solid</td>
</tr>
<tr>
<td></td>
<td>strong mixing required time/energy high</td>
<td>high content co-solvent negative environmentally</td>
<td>added pigment dispersion phase high particle size, adsorbed pigment surface</td>
</tr>
<tr>
<td><strong>Performance</strong></td>
<td>market standard (MS)</td>
<td>better than MS (+)</td>
<td>better than MS (+)</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>market standard (MS)</td>
<td>higher than MS (+)</td>
<td>higher than MS (+)</td>
</tr>
</tbody>
</table>

* *Clariant Hostavin Dispersion*
Light Stabilizers Additives for Waterborne Coatings

Non Waterbased

Waterbased*

* Patent protected
# Waterborne Dispersion Light Stabilizers Additives

<table>
<thead>
<tr>
<th>UV Absorber</th>
<th>Radical scavenger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzophenone (3042)</td>
<td>hindered amine (3070*)</td>
</tr>
<tr>
<td>Benzotriazole (3310)</td>
<td></td>
</tr>
<tr>
<td>Benzotriazole (3326)</td>
<td></td>
</tr>
<tr>
<td>Triazine (3330*)</td>
<td></td>
</tr>
</tbody>
</table>

## Properties

<table>
<thead>
<tr>
<th></th>
<th>low photopermance</th>
<th>good photopermance</th>
<th>good photopermance</th>
<th>best photopermance</th>
<th>low tox profile</th>
<th>low extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Properties</td>
<td>- low color</td>
<td>- high absorbance</td>
<td>- high &amp; broad absorbance</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Active content

<table>
<thead>
<tr>
<th></th>
<th>40%</th>
<th>52%</th>
<th>52%</th>
<th>52%</th>
<th>52%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active content</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Restriction

<table>
<thead>
<tr>
<th></th>
<th>none</th>
<th>none</th>
<th>solubility max 1.0-1.5%</th>
<th>compatibility poor in clear acrylic</th>
<th>none</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restriction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* EcoTain® label certification
Light stabilization of exterior clear wood coatings

Comparison of different UV stabilization packages

1.2% active UVA + 0.6% active HALS

Improved performance with BZT 3310 Disp & BZT Disp vs. BZT MS *(market standard)*

<table>
<thead>
<tr>
<th></th>
<th>initial</th>
<th>After 500 h</th>
<th>After 1000 h</th>
<th>After 1500 h</th>
<th>After 2000 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>No stabilization</td>
<td><img src="image1" alt="" /></td>
<td><img src="image2" alt="" /></td>
<td><img src="image3" alt="" /></td>
<td><img src="image4" alt="" /></td>
<td><img src="image5" alt="" /></td>
</tr>
<tr>
<td>BZT MST</td>
<td><img src="image6" alt="" /></td>
<td><img src="image7" alt="" /></td>
<td><img src="image8" alt="" /></td>
<td><img src="image9" alt="" /></td>
<td><img src="image10" alt="" /></td>
</tr>
<tr>
<td>+ HALS MST</td>
<td><img src="image11" alt="" /></td>
<td><img src="image12" alt="" /></td>
<td><img src="image13" alt="" /></td>
<td><img src="image14" alt="" /></td>
<td><img src="image15" alt="" /></td>
</tr>
<tr>
<td>BZT 3310 Disp</td>
<td><img src="image16" alt="" /></td>
<td><img src="image17" alt="" /></td>
<td><img src="image18" alt="" /></td>
<td><img src="image19" alt="" /></td>
<td><img src="image20" alt="" /></td>
</tr>
<tr>
<td>+ HALS MST</td>
<td><img src="image21" alt="" /></td>
<td><img src="image22" alt="" /></td>
<td><img src="image23" alt="" /></td>
<td><img src="image24" alt="" /></td>
<td><img src="image25" alt="" /></td>
</tr>
<tr>
<td>Hostavin 3326 Disp</td>
<td><img src="image26" alt="" /></td>
<td><img src="image27" alt="" /></td>
<td><img src="image28" alt="" /></td>
<td><img src="image29" alt="" /></td>
<td><img src="image30" alt="" /></td>
</tr>
<tr>
<td>+ HALS MST</td>
<td><img src="image31" alt="" /></td>
<td><img src="image32" alt="" /></td>
<td><img src="image33" alt="" /></td>
<td><img src="image34" alt="" /></td>
<td><img src="image35" alt="" /></td>
</tr>
</tbody>
</table>

*Substrate:* pine wood, *Coating:* WB acrylic clearcoat, *WOM exposure:* according to ISO 4892-2
Light stabilization of exterior clear wood coatings: Comparison of different UV stabilization packages

1.2% active UVA + 0.6% active HALS
Improved performance with HALS Disp vs. HALS (MS)

<table>
<thead>
<tr>
<th>Substrate: pine wood, Coating: WB acrylic clearcoat, WOM exposure: according to ISO 4892-2</th>
<th>Initial</th>
<th>After 500 h</th>
<th>After 1000 h</th>
<th>After 1500 h</th>
<th>After 2000 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>No stabilization</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
<tr>
<td>2.4% BZT 3326 Disp 0.6% HALS MS</td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
<td><img src="image10.png" alt="Image" /></td>
</tr>
<tr>
<td>2.4% BZT 3326 Disp 1.2% HALS 3070 Disp</td>
<td><img src="image11.png" alt="Image" /></td>
<td><img src="image12.png" alt="Image" /></td>
<td><img src="image13.png" alt="Image" /></td>
<td><img src="image14.png" alt="Image" /></td>
<td><img src="image15.png" alt="Image" /></td>
</tr>
</tbody>
</table>

(0.6% active)
Light stabilization of exterior wood stain coatings
Comparison of different UV stabilization packages

**Dosage:** 1.3% UVA + 0.7% HALS (% active on solid resins)

→ Improved performance with Hostavin Disp. vs. other WD grades

<table>
<thead>
<tr>
<th>Substrate: Pine wood, Coating: WB stain based on modified alkyd, WOM exposure: according to ISO 4892-2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dosage:</strong> 1.3% UVA + 0.7% HALS (% active on solid resins)</td>
</tr>
<tr>
<td><strong>2.0% UVA/HALS 53 WD</strong></td>
</tr>
<tr>
<td><strong>2.0% HPT WD+ HALS WD</strong></td>
</tr>
<tr>
<td><strong>2.0% UVA/HALS 51 WD</strong></td>
</tr>
<tr>
<td><strong>BZT 3326 Disp. HALS 3070 Disp.</strong></td>
</tr>
<tr>
<td><strong>HPT 3330 Disp. HALS 3070 Disp.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>ΔE after hrs. in WoM</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>0 2 4 6 8 10 12</td>
</tr>
</tbody>
</table>

- Improved performance with Hostavin Disp. vs. other WD grades
High performance solution for WB 1K & 2K coatings

UV stabilization in a WB 2K-PU:
WOM exposure according to ISO 4892-2 wet/dry
Dosage: 2% UVA + 1% HALS (%active on solid resins)

→ Improved performance of HPT 3330 Disp. vs. HPT WB

![Graphs showing gloss retention and color change over exposure time for different formulations.](image)
# Product Portfolio Review

## Light Stabilizers for WB, WB-UV Coatings

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<th>Products</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>UV Absorber</strong></td>
<td></td>
</tr>
<tr>
<td>HOSTAVIN 3042 disp.</td>
<td>UV Absorber for moderate durability, most cost effective</td>
</tr>
<tr>
<td>HOSTAVIN 3310 disp.</td>
<td>UV Absorber for good performance</td>
</tr>
<tr>
<td>HOSTAVIN 3326-2 disp.</td>
<td>UV Absorber with broad UV absorbance, best for wood coatings</td>
</tr>
<tr>
<td>HOSTAVIN 3330 disp. XP</td>
<td>Maximum dosage level 3% as is (dispersion) of binder solid</td>
</tr>
<tr>
<td><strong>Radical Scavenger (HALS)</strong></td>
<td></td>
</tr>
<tr>
<td>HOSTAVIN 3070 disp.</td>
<td>Low migration polymeric HALS for plastic &amp; wood coatings</td>
</tr>
<tr>
<td>HOSTAVIN 3068 liq.</td>
<td>Non-basic HALS for plastic coatings</td>
</tr>
</tbody>
</table>

**Synergistic solution UV Absorber + HALS:**

**HOSTAVIN TB 03**
- High performing light stabilizer solution (1 part Triazine UVA/ 1 part HALS)
- Compatible with SB and WB coatings, Xylene free

**Hostavin TB 04**
- High performing cost competitive light stabilizer solution (2 part Triazine UVA + 1 part HALS)
- Compatible with SB and WB coatings, Xylene free
Polymer Additives for Powder Coatings
Powder Coatings –
High Performance Process & Heat Stabilizers

**Antioxidant (Processing Stabilizer):** Hostanox P-EPQ

- Key benefits
  - High performance phosphonite based antioxidant
  - Reduced thermal yellowing during processing
  - Reduced gas fading (color) during curing in oven
  - Extended Long term heat stability (combined with UV stabilizers) in high end applications, e.g. for architectural coatings

**Antioxidant (Processing Stabilizer):** AddWorks LXR 558

- Key benefits
  - Cost competitive antioxidant solution
  - Reduced thermal yellowing during processing
  - Reduced gas fading (color) during curing in oven
1. Reduced Thermal Yellowing During Processing

Comparative thermal yellowing during processing

- AO-1: phenolic AO10
- AO-2: Hostanox O 3
- AO-3: Hostanox O 310
- AO-4: Hostanox P-EPQ

System: white pigmented, PES/Primid, at 200 °C, [AO] = 0.5% on total formulation
2. Reduced thermal yellowing during processing and improved overbaking resistance

**Comparative thermal yellowing during processing**

<table>
<thead>
<tr>
<th></th>
<th>200°C, 30 min</th>
<th>200°C, 60 min</th>
<th>230°C, 30 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>No additives</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Stab 1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Stab 2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Stab 3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Stab 4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

Stab 1: 0.5% HOSTAVIN® 3051
Stab 2: 0.5% HOSTAVIN 3051 + 0.3% AO-5
Stab 3: 0.5% HOSTAVIN 3051 + 0.3% AO-5 + 0.3% P-EPQ
Stab 4: 0.5% HOSTAVIN 3051 + 0.3% AO-2 + 0.3% P-EPQ

AO-2: Hostanox O 3
AO-5: thioether AO

System: white pigmented, PES/Primid
The stoving process decides on the required chemical class of antioxidant to use:

1) Directly fired gas oven
   - NO\textsubscript{X} gases are generated in the open flame
   - Severe yellowing occurs in the presence of phenolic AO’s
   - **Hostanox P-EPQ** is the solution!

2) Indirectly fired oven
   - No forming of NO\textsubscript{X} gases
   - Only thermo yellowing occurs
   - **Hostanox O 3, O 310 or P-EPQ** can be used, depending on the requirements
3. Reduced Gas Fading Issues when Curing with Directly Fired Ovens

- Comparative thermal stabilization efficiency, with and without NO\textsubscript{x} gases

PC system: white pigmented, PES/Primid, cured at 200 °C, [AO] = 0.5% on total formulation
Thank You...

Mouhcine Kanouni, Dr. Ing
BU Additives, Technical Marketing Coatings

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