Tinuvin® 880
Novel Light Stabilizer for Automotive Interior

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Content

- Market trends
  - Evolving requirements during past decades
  - Challenges for material suppliers and converters
- Drivers to develop a novel light stabilizer for automotive interior applications
- Introducing Tinuvin® 880
  - Product form and dosability
  - Light stability (LS) and surface aesthetics
  - Long-term thermal stability (LTTS)
  - Emissions & odor, acid interaction behavior
- Other substrates and applications
- Summary

Market Trends
Evolving Requirements and Challenges

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Processability

- Broad processing window (insensitive to sub-optimal processing conditions)
- Good flowability and mold reproduction
- Recyclability
- Enable design innovations

Mechanics

- High stiffness for structural integrity and lightweight constructions
- Good impact behavior, safety, e.g. for passengers (stiffness-impact balance)
- Low Coefficient of Linear Thermal Expansion (CLTE), low shrinkage and warpage (zero-gap design), good part tolerance control, better mating to metals

Surface Aesthetics

- Excellent initial properties (gloss, color match)
- Weatherability and long term thermal stability
- Retention of surface aspects (scratch, mar, visual properties)
- Paintability

“Secondary” Prop.

- Product safety & regulations
- Low emissions, low fogging, low VOC, low FOG, neutral odor
- Appropriate haptic (e.g. no/low blooming, no/low stickiness, soft touch)

For a given application/segment, the winning design combines many attributes

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Drivers to Develop a Novel Light Stabilizer for Automotive Interior Applications

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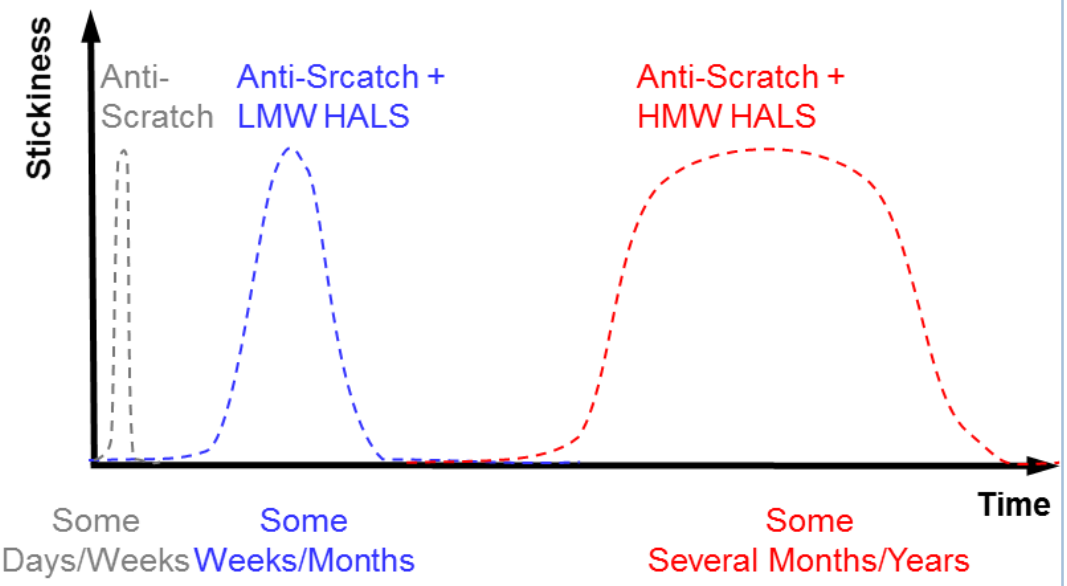
- Three Market Trends (three potential problem zones)
  #1: Extensive use of anti-scratch additives → potential blooming/surface-stickiness

Targets Conflict

- Compounding polymers in combination with certain additives (e.g. additives used for anti-scratch improvement) might lead to migration.
- Substances that migrated to the surface can degrade into components similar to tackifiers due to sunlight. Thus a sticky surface layer is created.
- Occurrence of such sticky surface layer depend on multiple parameters, incl. the polymer matrix, the migrating substance, and the chosen light stabilizer package.

Stickiness During Solar Exposure

- Different behavior of low and high molecular HALS
- HALS also acts as a stabilizer for the “stickiness effect”



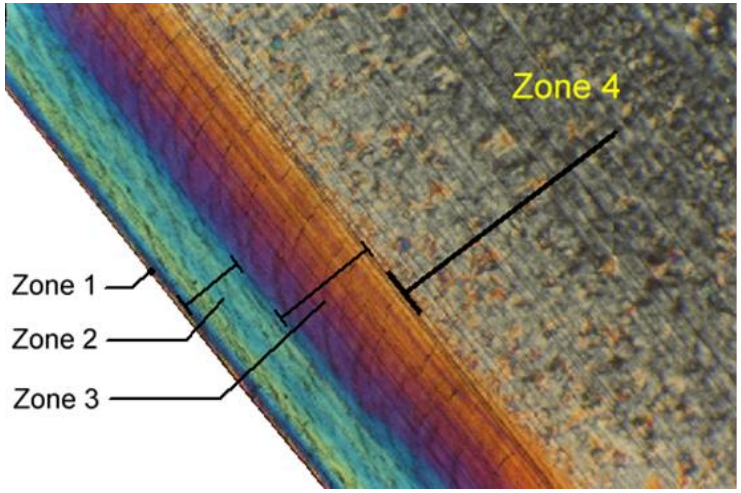
Unfavorable combinations may lead to failures in the field

Drivers to Develop a Novel Light Stabilizer for Automotive Interior Applications

- Three Market Trends (three potential problem zones)
  #2: More extreme processing conditions and thereof resulting polymer morphology

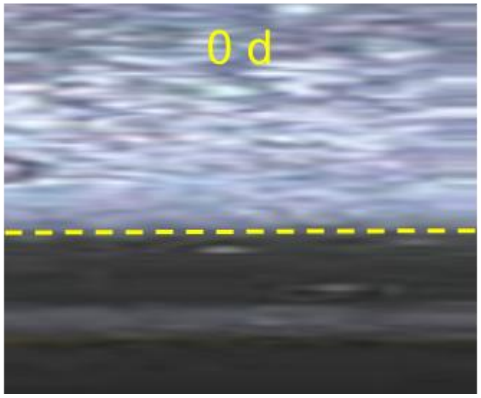
Processing Determines Morphology

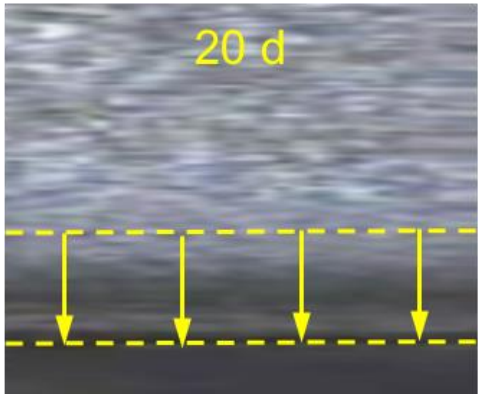
- Materials and processing conditions determine the morphology and thus the properties of the final part.
- Different processing conditions generate variations in morphology, leading to different migration behavior.



Morphology Affects Blooming/Stickiness

- The demand for reducing cycle time leads to fast injection rate and low mold temperature. Surface amorphous layer gets larger. Additives have higher solubility near surface.
- Re-crystallization reduces the amorphous volume, thus results in a higher concentration of additives, and eventually stickiness in combination with certain anti-scratch additives.





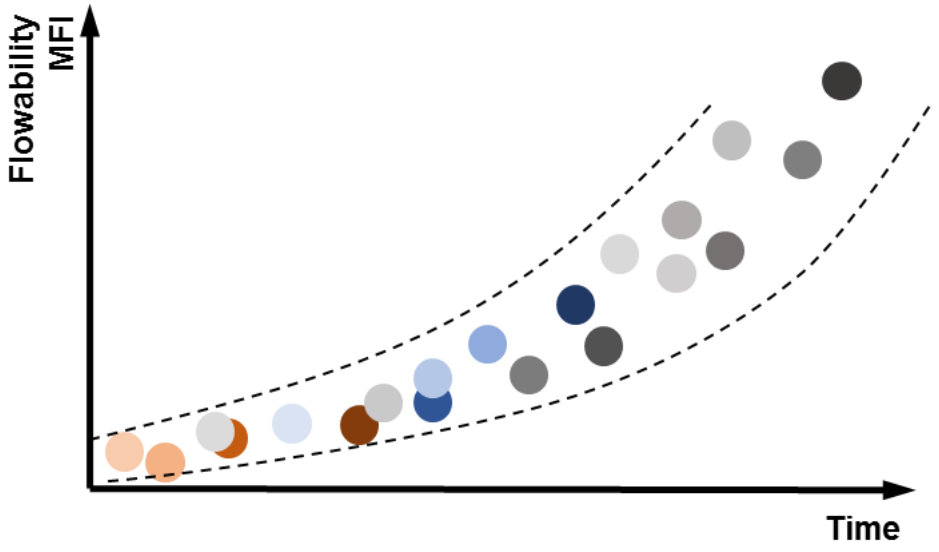
Unfavorable combinations may lead to failures in the field

Drivers to Develop a Novel Light Stabilizer for Automotive Interior Applications

- Three Market Trends (three potential problem zones)
  #3: Extensive use of polymers with high melt flow

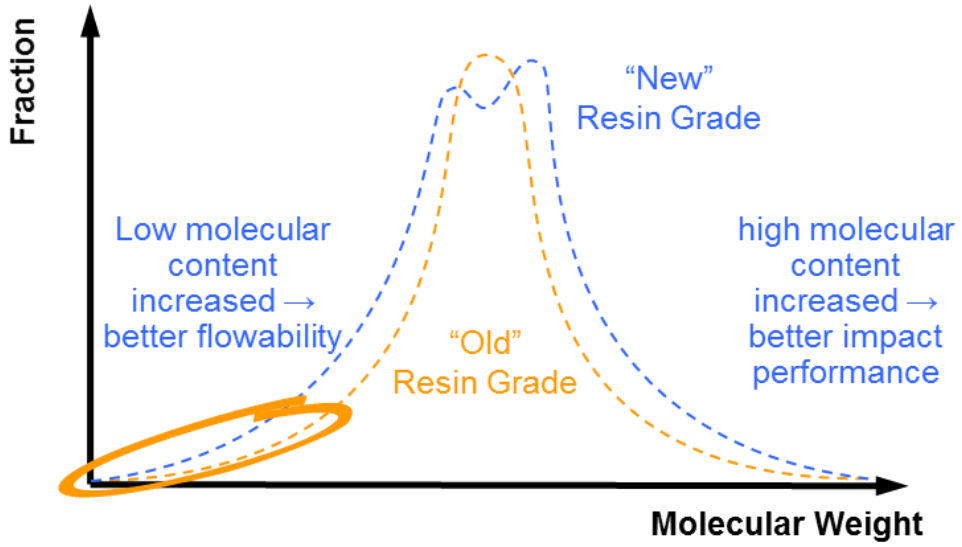
Polymer Rheology

- One target in last decade was to optimize flow properties. Polymer grades with high melt flow gained more attractions.
- High flow grades enable more complex part geometries.



Increased Low Mw Content

- The higher melt flow is obtained by decreasing the Mw, or combination of shorter chains and longer chains, which are needed to maintain stiffness and impact properties.
- Increased low Mw content might lead to more migrations.



Unfavorable combinations may lead to failures in the field

Drivers to Develop a Novel Light Stabilizer for Automotive Interior Applications

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- Major changes have taken place in the plastic industry over the last decades
  1) Anti-scratch additives → increased blooming
  2) More severe processing → potential for sub-optimal morphology
  3) High-flow grades → more low molecular weight content

- "Sticky Surface" is a result of inappropriately formulated combination of additives and components (not one component alone!)
  - Matrix and its properties (processing, morphology, molecular weight distribution, …)
  - Sum of all "additives" (stabilizer, anti-scratch, fillers, dispersing aid, filler deactivator …)

➡ Take on the challenges rising from the latest trends in the automotive industry.

➡ Develop a new HALS specifically to fulfill unmet needs and stringent requirements.

New development to enable optimized solution for automotive market trends

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Introducing a Novel Light Stabilizer

BASF Tinuvin® 880

Designed to meet all important industry standards

- Appearance: White crystalline granules
- Chemical class: N-R
- Molecular weight: Medium
- Composition: 100 % (neat additive)
- Melting point: > 100 °C
- Volatility: Low
  (TGA weight loss)

Brand-new chemistry, specifically optimized for automotive PP/TPO interior parts

Tinuvin® 880
Product Form and Dosability (Pressure-Storage-Test)

	Tinuvin® 880	Competition 1 (HALS MB)	Competition 2 (HALS+BZ MB)	Competition 3 (HALS+BZ MB)
Initial (As received)	 ✓	 ✗	 ✗	 ✗
Initial (Broken-up)	✓ **Good to Use**	 ✓	 ✓	 ✓
72 h at 40 °C (2 bags in carton box)	 ✓	✗ **Not able to measure** (Not possible to purge material out of glass cylinder)	 ✗	 ✗
72 h at 50 °C (bags on pallet)	 ✓	✗ **Not able to measure** (Not possible to purge material out of glass cylinder)	✗ **Not able to measure** (Not possible to purge material out of glass cylinder)	✗ **Not able to measure** (Not possible to purge material out of glass cylinder)

Product form of Tinuvin® 880 is far more user friendly than competitive systems

Tinuvin® 880
Automotive Interior Weathering

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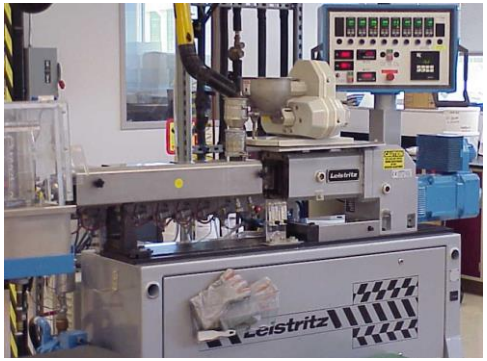
Experiment and Exposure

Polymer:	State-of-the-Art Automotive PP/TPO
Color:	Black
Filler:	20 % Talc
Anti-Scratch:	Yes
UV Stabilizer:	0.2% active

Processing:	Twin-screw Compounding, 230 °C Injection Molding Plaques, 230 °C

Weathering:	PV1303, VW interior, Dry Xenon Continuous light, 1.2 W/m^2 @ 420 nm Black Standard Temp: 100 °C
Testing:	Gray Scale, Delta E



Harsh Interior Weathering – very high temperature, very high irradiance

Tinuvin® 880
Surface Aesthetics (Non-Blooming, Non-Stickiness)

0.2 % Ester HALS	0.2 % Tinuvin® 880	0.4 % Competition 1 (HALS MB)	0.4 % Competition 2 (HALS+BZ MB)	0.4 % Competition 3 (HALS+BZ MB)
				
				

Tinuvin® 880 is equivalent as non-blooming light stabilizer to competitive systems

Tinuvin® 880
Surface Aesthetics (Non-Blooming, Non-Stickiness)

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0.2 % Ester HALS	0.2 % Tinuvin® 880	0.4 % Competition 1 (HALS MB)	0.4 % Competition 2 (HALS+BZ MB)	0.4 % Competition 3 (HALS+BZ MB)
1000 h ✗	✓	✓	✓	✓
2000 h ✗	✓	✓	✗	✓

Tinuvin® 880 is equivalent as non-blooming light stabilizer to competitive systems

Tinuvin® 880
Light Stability (Gray Scale)

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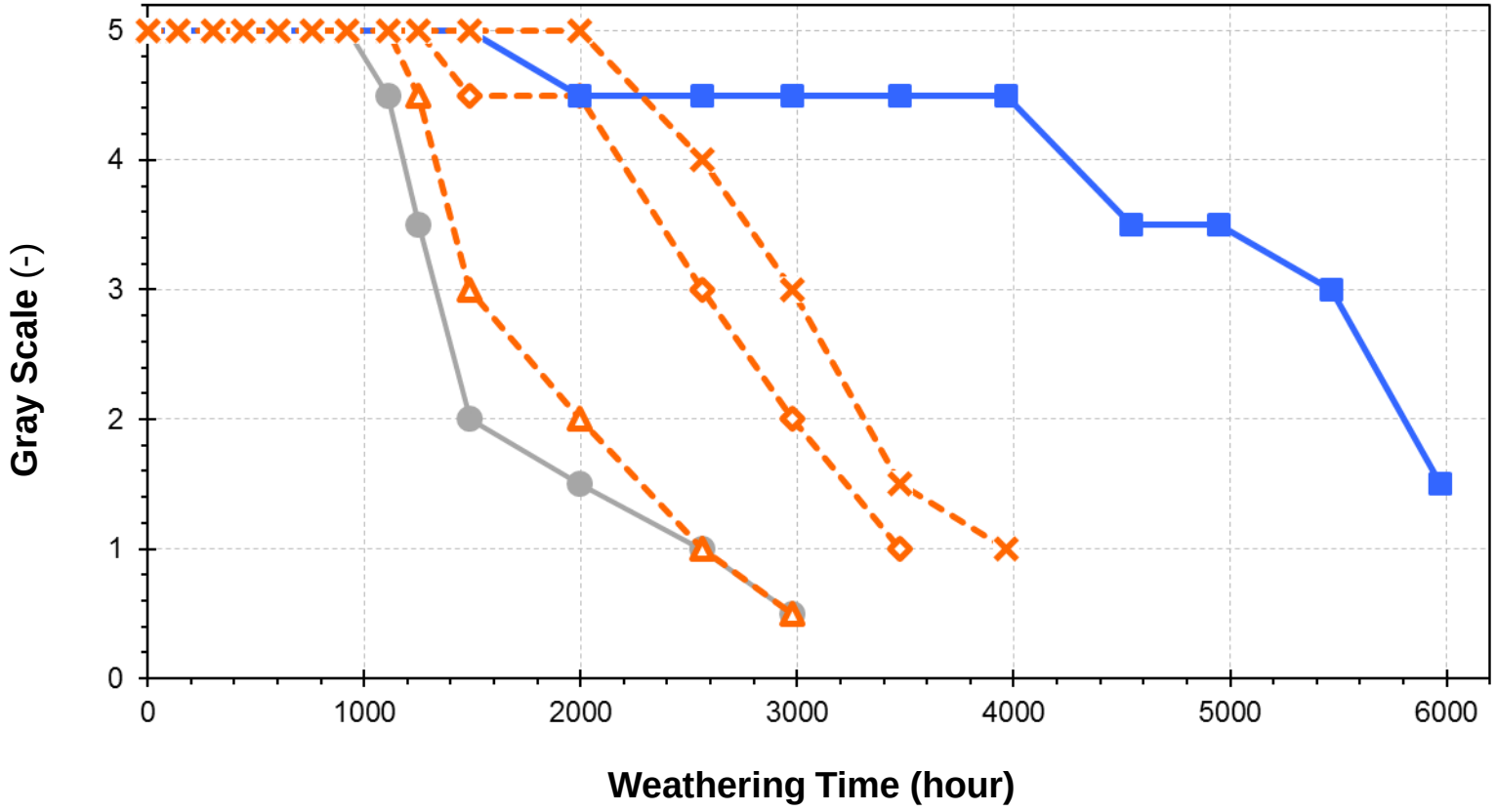
Interior Weathering

Polymer:	State-of-the-Art Automotive PP/TPO
Color:	Black
Filler:	20 %
Anti-Scratch:	Yes
UV Stabilizer:	0.2% active
Processing:	Compounding TSE, 230 °C Injection Molding Plaques, 230 °C
Aging:	Artificial Weathering Xenon, Dry, PV 1303
Testing:	Gray Scale



Superior weathering performance, especially in very demanding interior weathering

Tinuvin® 880
Light Stability (Delta E)

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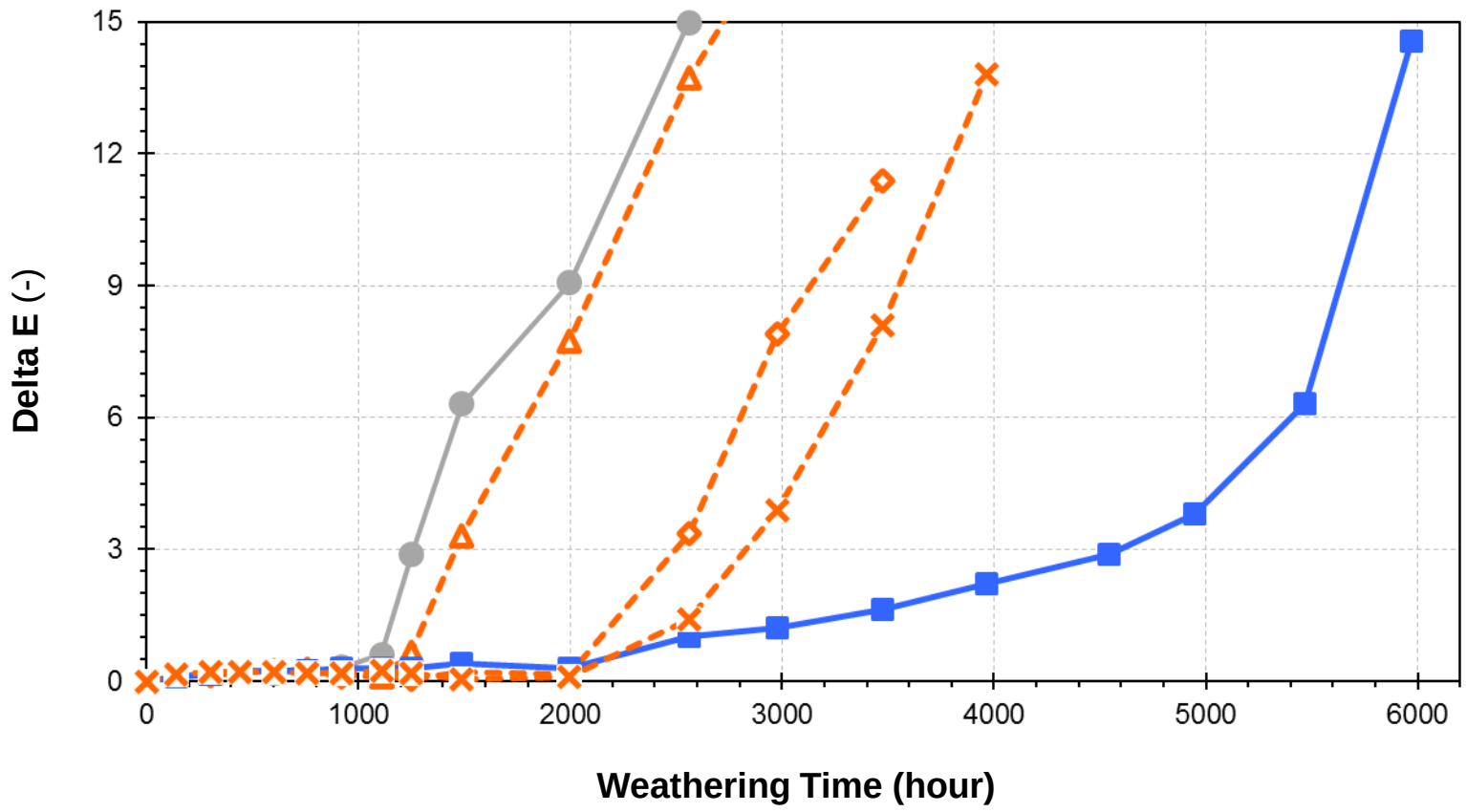
Interior Weathering

Polymer:	State-of-the-Art Automotive PP/TPO
Color:	Black
Filler:	20 %
Anti-Scratch:	Yes
UV Stabilizer:	0.2% active
Processing:	Compounding TSE, 230 °C Injection Molding Plaques, 230 °C
Aging:	Artificial Weathering Xenon, Dry, PV 1303
Testing:	Gray Scale



Superior weathering performance, especially in very demanding interior weathering

Tinuvin® 880
Long-term Thermal Stability (150 °C)

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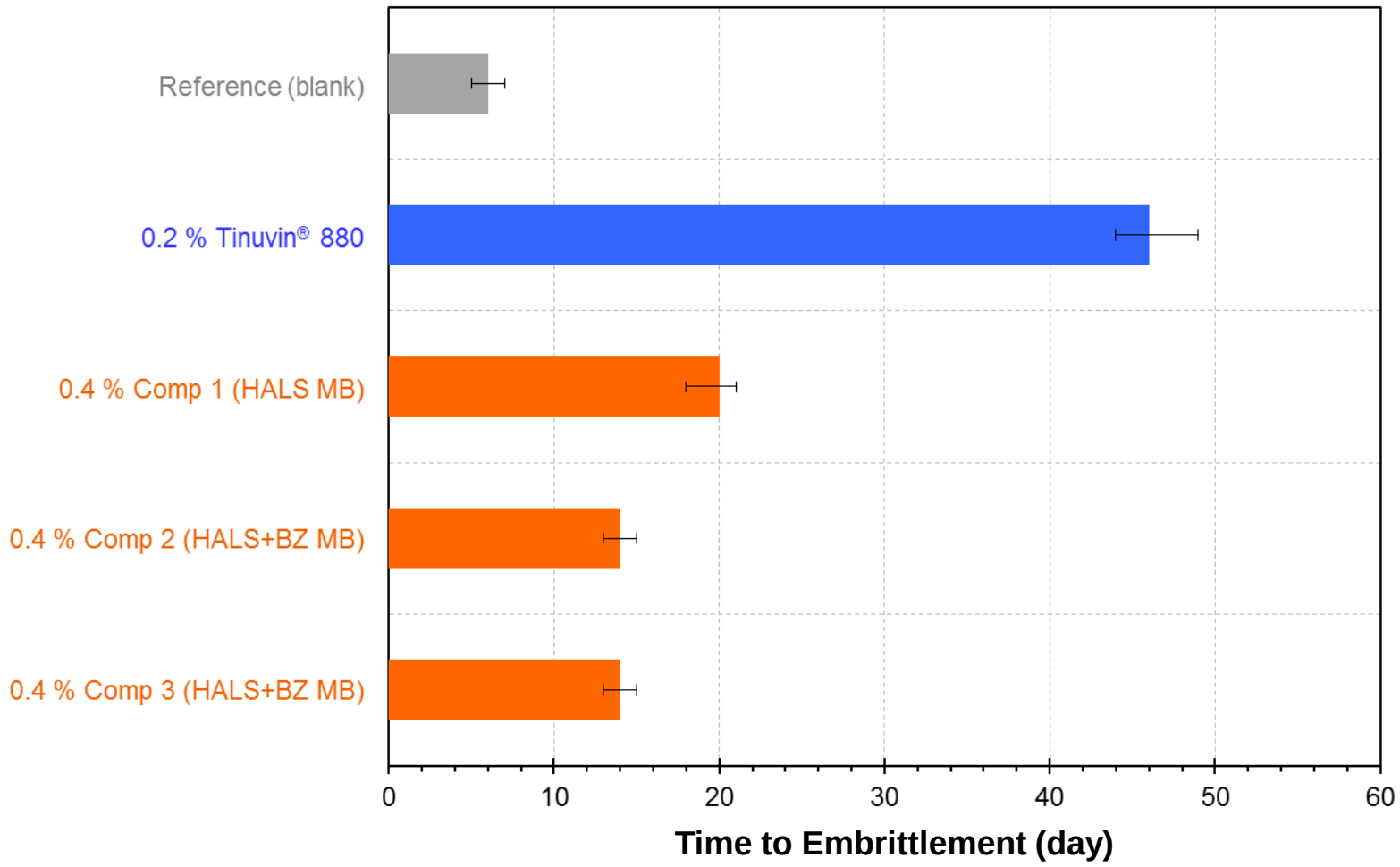
Oven Aging

Polymer:	State-of-the-Art Automotive PP/TPO
Color:	Black
Filler:	20 %
Anti-Scratch:	Yes
UV Stabilizer:	0.2% active
Processing:	Compounding TSE, 230 °C Injection Molding Plaques, 230 °C
Aging:	Oven Aging 150 °C
Testing:	Embrittlement

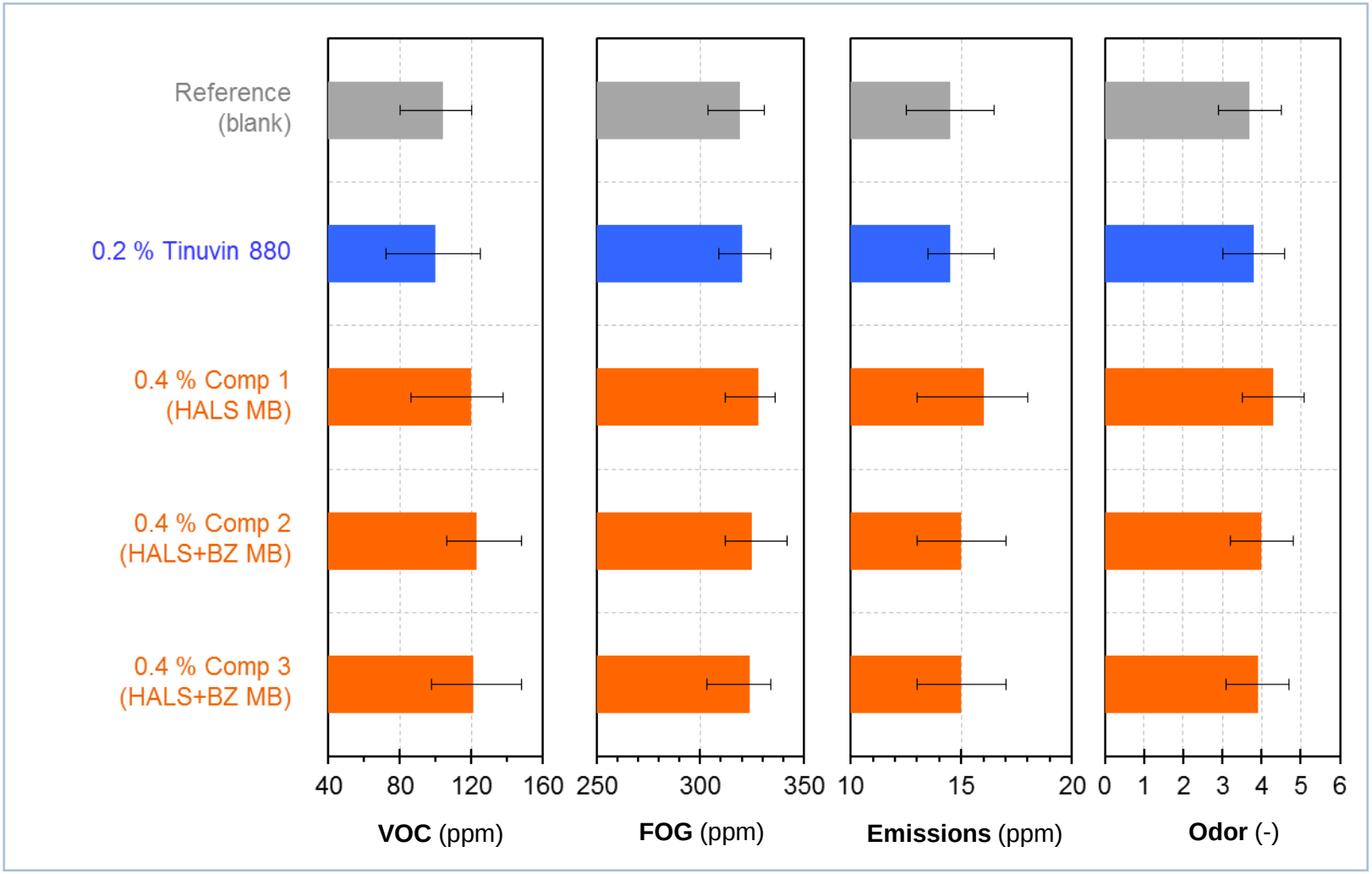


Superior long-term thermal stability, even at high temperature

Tinuvin® 880
Emissions and Odor

Emissions and Odor

Polymer:	State-of-the-Art Automotive PP/TPO
Color:	Black
Filler:	20 %
Anti-Scratch:	Yes
UV Stabilizer:	0.2% active
Processing:	Compounding TSE, 230 °C Injection Molding Plaques, 230 °C
Aging:	None
Testing:	VDA 278, VDA 276, VDA 270



No contribution to emissions and odor

Tinuvin® 880
Mold Deposition Behavior (Acid Interaction Behavior)

- Mold deposit can be generated, when light stabilizers based on HALS chemistry interact with acidic species and form an insoluble salt.
- To simulate this effect during processing, Tinuvin® 880 is mixed with stearic acid, and no precipitation is observed.

➡ No precipitate

➡ No insoluble salt has been formed

➡ No/low tendency for the formation of a mold deposit

Problem-free injection molding without mold deposit

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Tinuvin® 880
Other Substrates and Applications

- Suitable substrates
  - Chemistry very effective in all kind of polymers, like thermoplastics and elastomers
  - Performance optimized for polyolefins, esp. all grades of PP/TPOs both filled and unfilled
  - Suitable substrates include PP, PE, PA, POM, styrenic, styrenic-block-copolymers, alloys (e.g. PC/ABS, PC/ASA) and blends and many others
  - Possible substrates are also elastomers and duroplasts

- Suitable applications
  - Performance of new light stabilizer perfectly suited for PP/TPO used in automotive interior applications like instrument panels, interior trims, consoles etc., as well as exterior applications like bumpers, fenders or others
  - The use of Tinuvin® 880 is not limited to automotive: other possible applications range from building & construction, e.g. roofing, siding and others, household/appliances, electrical and electronics, rubbers and elastomers, agro, packaging, fibers and tapes

Tinuvin® 880: Universal applicability across a broad range of thermoplastics and applications

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Tinuvin® 880
Summary of Key Features and Benefits

- Performance as light stabilizer
  - Excellent weathering performance and surface protection, esp. in very long lasting applications, even at low loading levels (very efficient)
  - Very low/no migration behavior, even in anti-scratch improved polymer grades
  - Can be used with migratory anti-scratch: Non-migratory Si-based can be potentially replaced by more cost effective migratory anti-scratch (depending on polymer matrix)
- Performance as long-term-thermal-stabilizer
  - Best-in-class thermal aging behavior, esp. at very high temperatures like 150 °C
- Secondary properties
  - No blooming or stickiness
  - No development of emissions or odor
  - No negative impact on paintability
- Product form
  - 100 % active additive enabling more freedom for tailor made formulations
  - Easy dosing (high melting temperature well above problematic temperatures; no stickiness/ lumping; “ED” Durable Dust Free product form