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# **Advances in Flame Retardant Compositions**

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Chicago, Illinois**

# Selected “Traditional” FR Materials for Polyolefins

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- **Halogenated compounds**
  - Tetrabromobisphenol A bis(2,3-dibromopropyl ether) (PE-68)
  - Decabromodiphenyloxide (DBDPO)
  - Brominated phosphate ester (FR 370)
- **Phosphates**
  - Ammonium polyphosphate
  - Isopropyl diphenylphosphate
- **Inorganics**
  - Magnesium hydroxide
  - Antimony oxide (synergist for halogenated FR)

# New FR Solutions for Polypropylene

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- **Halogen-free FR for PP fibers & films**
- **Antimony-free FR systems for PP moldings**
- **FR and light stabilizer systems for weatherable PP moldings**

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# Halogen-Free FR for PP Fibers & Films

“NOR 1”

**Ciba® FLAMESTAB® NOR 116**

# Features and Benefits of NOR 1

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- **Halogen-free**
- **Active at low concentrations**
  - No effect on fiber/film properties
  - Good cost performance
- **Melt processible**
  - Easy dispersion
  - No spinneret clogging
- **Contributes to UV and thermal oxidative stability of PP fibers & films**

# NOR 1 as a FR in PP Fibers

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## NFPA 701 Test (1996)

<b>Additive</b>	<b>Weight Loss (%)</b>	<b>Drip Burn Time (sec)</b>	<b>Rating</b>
None	34	97	Fail
<b>1.0% NOR 1</b>	<b>29</b>	<b>0.5</b>	<b>Pass</b>

# NOR 1 as a FR in PP Films

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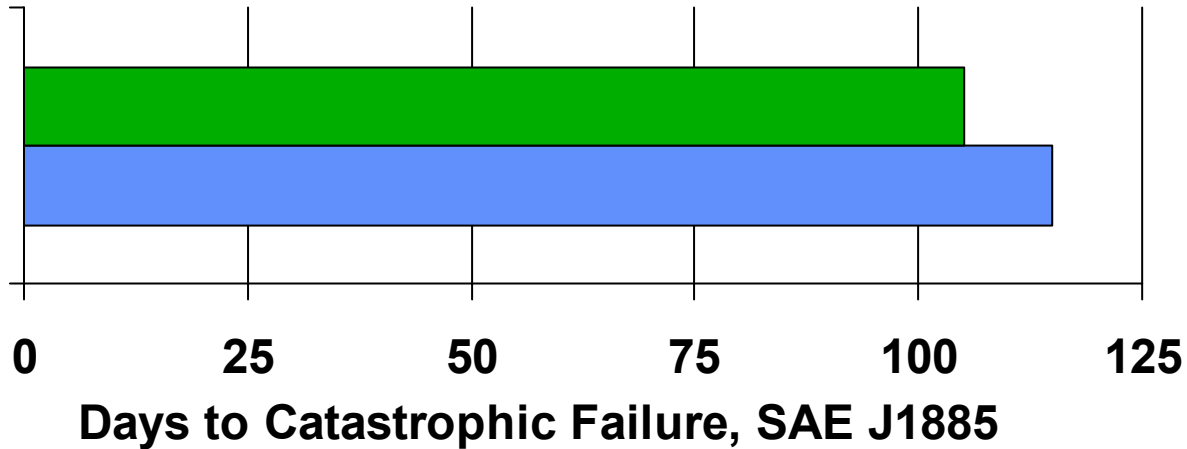
**No FR**

**1% NOR 1**

**NFPA 701 (1989)**

**Molded PP Films,  
thickness 0.010"**

# NOR 1 as a Light Stabilizer in PP Fibers



■ 1% CHIMASSORB® 119

■ 1% NOR 1

Fibers with 0.25 % Pigment Red 144  
Xenon arc weatherometer, interior automotive conditions

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# Antimony-Free FR Systems for Polypropylene Moldings

**System A = EB 42-81**

**System B = EB 42-80**

**to be commercialized under Ciba® FLAMESTAB® brand**

# Why Antimony Oxide?

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- Increased effectiveness of halogenated FR
- Reduced halogenated FR use levels

## Synergistic Effect

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- Catalytic synthesis of volatile species such as  $\text{SbX}_3$  which interfere with vapor-phase combustion chemistry

# Benefits of Antimony-Free Systems

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- **Antimony-free**
  - *Reduced HS&E issues*
  - *Lower FR polymer density*
  - *No negative impact in the mechanical properties of the polymer such as tensile and impact strength*
- **Lower Levels of Halogenated FR**
  - *Less effect on mechanical properties*
  - *Reduced halogen content*
- **Dispersible for easy compounding**
- **Non-blooming (System A)**
- **UV-stable FR (System A)**

# Test Protocol

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- **Compounding**

Blending of polymer & additives for 30 min

Twin screw extruder (27 mm) at 200°C, 300 rpm feeding  
200 rpm screw speed, under nitrogen

- **Injection Molding**

BOY 50M, zone temps. 204, 218, 232°C, nozzle 232°C

Mold temp. 24°C

- **FR Testing**

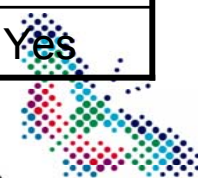
UL 94 protocol

# UL 94 Test Criteria

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- Each of five replicate test specimens are ignited twice.
- The time the specimen continues to burn once the flame is removed is recorded for each occasion and each sample. The time the specimen glows after it extinguishes is also recorded.
- Also noted is if the sample burns to the holding clamp and if burning drips from the specimen ignite a cotton indicator below the sample.

	<b>V-0</b>	<b>V-1</b>	<b>V-2</b>
Max afterflame for each specimen, first or second burn	≤10 sec	≤30 sec	≤30 sec
Total afterflame for all five specimens, both burns	≤50 sec	≤250 sec	≤250 sec
Afterflame + afterglow for each specimen	≤30 sec	≤60 sec	≤60 sec
Specimen burns to clamp?	No	No	No
Cotton ignited by burning drips?	No	No	Yes



# Physical Properties of FR PP Homopolymer

System	UL 94	MFI	Izod Impact (ft-lb/in)	Tensile Strength (kg/ mm <sup>2</sup> )	Total Elongation (%)
No FR	NR	4.5	0.78	4.37	805
16% System A	V-0	8.3	0.74	4.25	906
3.5% System A	V-2	4.8	0.76	4.55	836
5.5% System B	V-2	5.6	0.74	4.30	878
12% PE68 4% Sb <sub>2</sub> O <sub>3</sub>	V-0	9.3	0.62	4.02	871

- Physical properties of FR PP are not compromised by new FR systems

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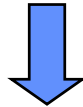
# Flame Retardant, Light-Stabilizer Systems for Weatherable Polypropylene Moldings

**System C**  
**Ciba® TINUVIN® FR**

# **Traditional FR Systems are Detrimental to UV Stability!**

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**Aromatic brominated FR are not UV stable**



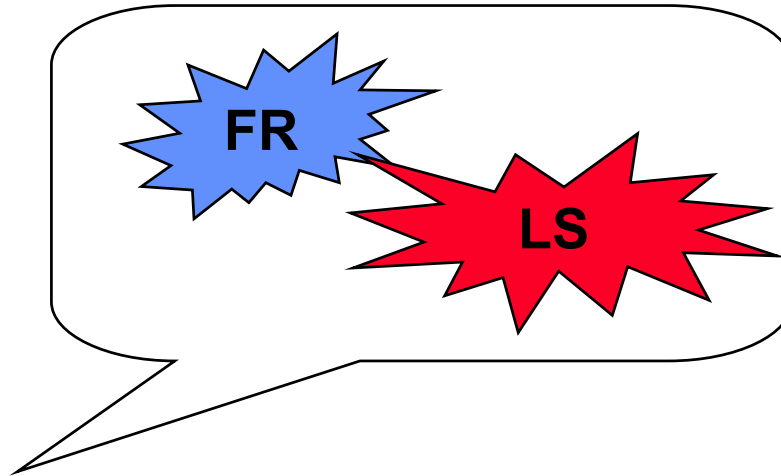
**Release of Br radicals, HBr**



- **Deactivate hindered amine light stabilizers**
- **Initiate photodegradation of the polymer**

# The Performing Solution

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**SYSTEM C** → **For weatherable FR PP**






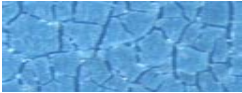

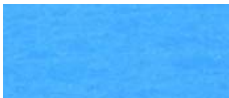


# Benefits of System C

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- **Superior light stability vs. other LS/FR systems**
- **Easy to handle and dose**
- **Technical support by Ciba to ensure final formulation meets end user requirements**

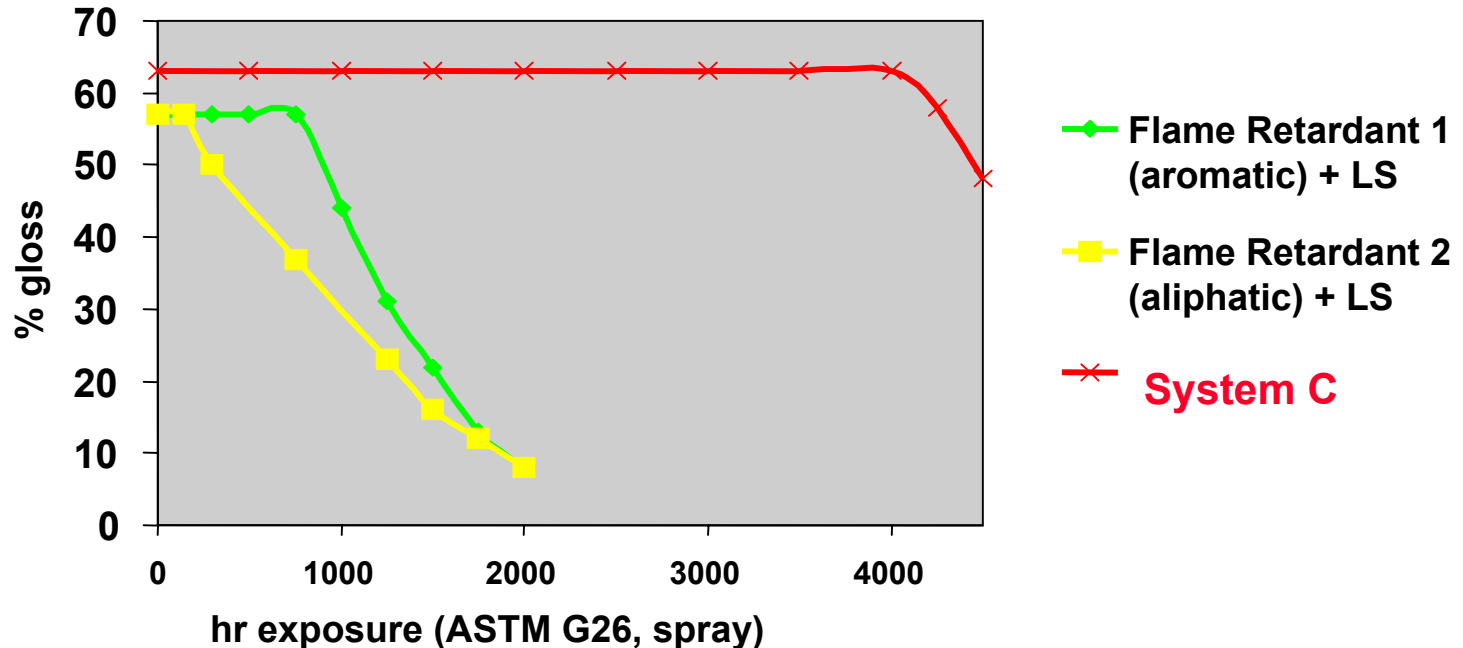
# System C vs. Conventional Systems

Artificial Weathering: Xenon arc weatherometer, ASTM G26 with spray

	1000 h	2000 h	3000 h	4000 h
Flame Retardant 1 (aromatic) + LS				
Flame Retardant 2 (aliphatic) + LS				
<b>System C</b>				

Substrate: PP copolymer, 0.2% CHROMOPHTAL Blue 4 GNP  
FR Rating: UL 94 V-2

# Gloss Retention During Weathering



**Artificial Weathering: Xenon arc weatherometer**

Substrate: PP copolymer, 0.2% CHROMOPHTAL Blue 4 GNP

FR Rating: UL 94 V-2

# From Design to Reality

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**Flame-retarded, light stabilized seating with System C  
Munich Olympic Stadium, 2002**

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# New Experimental Flame Retardant and Light Stabilizer for HIPS Applications

# Features and Benefits of New System

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- **Antimony-free**
  - *Reduced HS&E issues*
  - *Lower FR compound density*
- **Improved UV stability compared with state of the art**
  - *Meet light stability requirement after exposure per ASTM D4459-93*
- **Easier to color for high-chroma colors**
  - *Lower loadings of pigments for cost savings*
  - *No effect of  $Sb_2O_3$  which acts as a white pigment*
- **Cost efficient FR system for V-2 HIPS**
- **Melt blendable & easy to disperse**

# Weathering: New vs. Conventional System

Artificial Weathering: ASTM G 26, with spray

New Ciba FR/LS system

State of the art Flame retardant + LS



Reference Sample



After 1000h artificial weathering

Non pigmented injection molded HIPS  
Flame Retardant: conc. to fulfill UL 94 V-2  
Same LS conc. in both formulation