

Great Lakes Solutions

Flame Retardants Product Guide



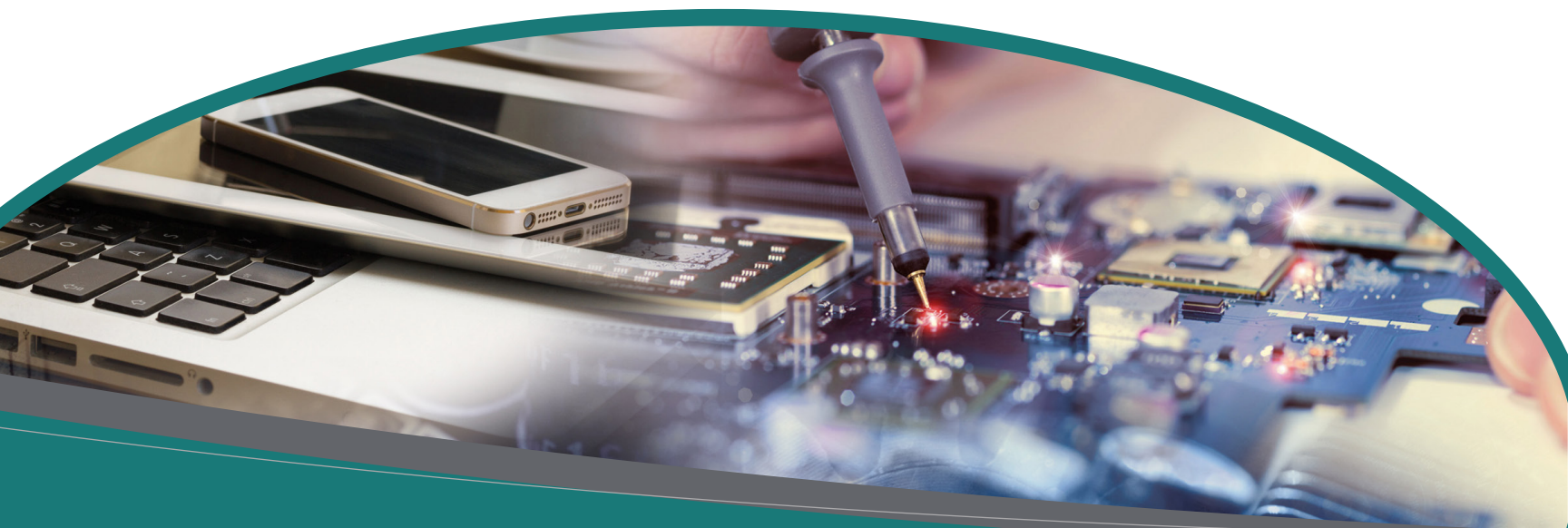
Global Leader In Flame Retardants

Innovative. Reliable. Sustainable.

Resulting from decades of hard work, innovation and lessons learned, the Great Lakes Solutions of today is positioned to be our customers' best partner for bromine, phosphorus and antimony-based flame retardant needs, both today and far into the future.

For almost a century, we have helped our customers to meet their flame retardant needs with a broad portfolio of products and solutions. In late 2010, Chemtura introduced the Great Lakes Solutions business with a mission to build on its well-established heritage, by introducing differentiated, innovative products and greener, sustainable solutions while maintaining performance and quality.

We are proud of our history and look forward to helping our customers meet future performance, safety and compliance requirements by constantly improving our portfolio with new and improved products for maximum sustainability.



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Flame Retardants - Saving Lives

Fire kills thousands of people each year throughout the world, but many are spared because fires are slowed or never start due to the use of flame retardants. Great Lakes Solutions is a global leader in flame retardant products and solutions for use in applications such as furniture foam, electronic components, electrical enclosures, building products and more.

Great Lakes Solutions believes the public should not be forced to choose between environmental and fire safety and that we must have both. Our business demands the highest standards of both fire retardancy performance and environmental sustainability. To meet these increasingly complex challenges, Great Lakes Solutions offers a wide range of flame retardant solutions that allow OEM's the versatility to meet their individual needs.

Brominated flame retardants are used in a variety of applications from electronic housings to printed circuit boards and electrical connectors to flexible and rigid polyurethane foam. Brominated flame retardants provide optimal processing while maintaining outstanding physical properties in a cost effective manner.

Phosphorus flame retardants are popular for electronic housings and where improved UV stability is important. Our phosphorus flame retardants are used extensively in a wide variety of applications. Antimony trioxide is used as a synergist in many polymers when combined with brominated flame retardants and can be used alone as a flame retardant in PVC. Our antimony-based synergists are used in polymers, paints, textiles, polyesters, coatings, elastomers and rubber compounds.

Flame Retardants Selection Guide

- Recommended
- ▶ Suitable

Bromine-Based Flame Retardants

	POLYOLEFINS				PVC	STYRENICS		PC/ABS (Polycarbonate /ABS Blends)	PPE/HIPS Blends	XPS	EPS	POLYURETHANE			THERMOSETS			ENGINEERING THERMOPLASTICS						
	Polypropylene	Polyethylene	TPO (Thermoplastic Polyolefin)	EPDM		HIPS (High Impact Polystyrene)	ABS					Rigid Polyurethane(PUR/PIR)	Flexible Polyurethane	TPU	UPE (Unsaturated Polyester)	Epoxy	Phenolics	PA 6	PA 66	HTPA	PBT	PET	PC	
Emerald Innovation® 3000										●	●													
PDBS-80™																			●	●	●	▶	▶	
Firemaster® CP-44HF																			●	●	●	▶	●	
Firemaster® PBS-64HW																			●	●	▶	●	●	
PHT-4™ †																								
PHT4-Diol™ †												●		●										
PHT4-Diol LV™ †												●		●										
DP-45™				▶	●																			
BA-59P™ †																●	●							
Firemaster® BZ-54*					▶						●					●	▶	▶						
Firemaster® 600*																●								
Firemaster® 602*																●								
BC-52™																						●		●
BC-58™																						●		●
Firemaster® 2100R	●	●	●	●		●	●	▶						●		●	▶		▶			●		
PH-73FF™ †															●				▶					

† Reactive flame retardant used during polymerization. *Products not registered for sale in Europe.

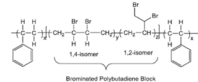


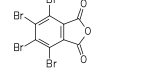
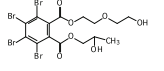
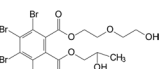
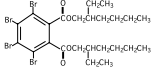
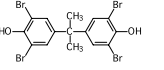
Flame Retardants Selection Guide

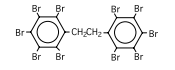
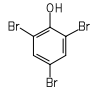
- Recommended
- ▶ Suitable

	POLYOLEFINS				PVC	STYRENICS					POLYURETHANE			THERMOSETS			ENGINEERING THERMOPLASTICS							
	Polypropylene	Polyethylene	TPO (Thermoplastic Polyolefin)	EPDM		HIPS (High Impact Polystyrene)	ABS	PC/ABS (Polycarbonate /ABS Blends)	PPE/HIPS Blends	XPS	EPS	Rigid Polyurethane(PUR/PIR)	Flexible Polyurethane	TPU	UPE (Unsaturated Polyester)	Epoxy	Phenolics	PA 6	PA 66	HTPA	PBT	PET	PC	
Phosphorus-Based Flame Retardants																								
Emerald Innovation® NH-1					●							▶	●	▶										
Reofos® 35					●							▶	●	●			▶							
Reofos® 50					●							▶	▶	●		●	▶							
Reofos® LF-50					●			▶	▶			▶	●	●		●	▶							
Reofos® 65					●							▶	●	●		●	▶							
Reofos® 95				▶	●							▶	●	●		●	▶							
Kronitex® CDP					●							▶	●	●		●	▶							
Kronitex® TCP					●									●			▶							
Kronitex® TXP					●																			
Antimony-Based Synergists																								
TMS®/ Timonox® Red Star/Fireshield®	●	●	●	●	●	●	●	●	●				▶	●	●	●	●	●	●	●	●	●	●	●
H / Thermoguard® S*	●	●	●	●	●	●	●	●	●				▶	●	●	●	●	●	●	●	●	●	●	●
Trutint®/ Fireshield® L / Thermoguard® L*	●	●	●		●	●	●	●	●				▶	●	●	●	●	●	●	●	●	●	●	●
Microfine®/ Ultrafine™ II*	●	●	●		●	●	●	●	●				▶	●	●	●	●	●	●	●	●	●	●	●
Pyrobloc® SAP2 / Thermoguard® FR*																							●	
Other Synergists / Smoke Suppressants																								
Zinc Borate ZB-223					●										▶									
Zinc Borate ZB-467	●	●	●	●	●	▶							●		●	●	▶	●	▶	●				
Smokebloc® blends					●										▶									
Ongard® 2					●																			
Thermoguard® CPA					●										▶									

† Reactive flame retardant used during polymerization. *Products not registered for sale in Europe.

Bromine-Based Flame Retardants

	Viscosity/ Melting Range °C	Volatility TGA, Wt. Loss @ Temp	Typical Specific Gravity	Bulk Density g/ml	Solubility (g/100 g solvent @ 25 °C)
Emerald Innovation® 3000 Brominated Polymeric Bromine Content: 64%	 CAS No. 1195978-93-8	Softening 120 5% @ 255°C 10% @ 260°C 50% @ 280°C	1.9	0.5 (L) 0.7 (P)	Water Methylene Chloride Methanol Styrene <0.1 >20 <0.1 >20
PDBS-80™ Poly (dibromostyrene) Formula Weight: 50,000 Bromine Content: 59.0%	 CAS No. 88497-56-7	Tg: 144 5% @ 368°C 10% @ 378°C 50% @ 404°C 95% @ 544°C	1.9	1.11 (P)	Water Dichloromethane Toluene Methanol MEK <0.1 C C <0.1 2
Firemaster® CP44-HF Copolymer of Dibromostyrene Formula Weight: ~16,000 Bromine Content: 64-65%	Proprietary CAS No. 88497-56-7	Tg: 147 1% @ 316°C 5% @ 347°C	2.0		Water Toluene Methylene Chloride MEK Methanol Acetone Insoluble C P P Insoluble Insoluble
Firemaster® PBS-64HW Poly (dibromostyrene) Formula Weight: 40,000 Bromine Content: 64.0%	 CAS No. 88497-56-7	Tg: 156 5% @ 356°C 10% @ 371°C 50% @ 401°C	2.0	1.25 (P)	Water Dichloromethane Toluene Methanol MEK <0.1 C C <0.1 P
PHT4™ Tetrabromophthalic anhydride Formula Weight: 463.7 Bromine Content: 68.2%	 CAS No. 632-79-1	274 – 277 5% @ 229°C 10% @ 242°C 50% @ 277°C	2.9	1.37 (L) 2.09 (P)	Water Dichloromethane Toluene Methanol MEK <0.1 1 6 1.6 2.6
PHT4-Diol™ Tetrabromophthalate diol Formula Weight: 627.9 Bromine Content: 46.0%	 US CAS No. 77098-07-8 EU CAS No. 20566-35-2	90,000 cps @ 25°C 5% @ 128°C 10% @ 166°C 50% @ 319°C 95% @ 380°C	1.9		Water Dichloromethane Toluene Methanol MEK <0.5 C C 9 C
PHT4-Diol™ LV Tetrabromophthalate diol Formula Weight: 627.9 Bromine Content: 43%	 CAS No. 77098-07-8 EU CAS No. 20566-35-2	22,500 cps @ 25°C 5% @ 127°C 10% @ 151°C 50% @ 325°C 95% @ 382°C	1.7		Water Dichloromethane Toluene Methanol MEK <0.5 C C 9 C
DP-45™ Tetrabromophthalate ester Formula Weight: 706.1 Bromine Content: 45%	 CAS No. 26040-51-7	1800 cps @ 25°C 5% @ 211°C 10% @ 226°C 50% @ 268°C 95% @ 291°C	1.6		Water Dichloromethane Toluene Methanol MEK <0.1 C C 5.7 C
BA-59P™ Tetrabromobisphenol A Formula Weight: 543.7 Bromine Content: 59%	 CAS No. 79-94-7	179-182 5% @ 244°C 10% @ 261°C 50% @ 301°C	2.2	0.96 (L) 1.36 (P)	Water Acetone Dichloromethane Toluene Methanol MEK <0.1 225 27 6 80 168
Firemaster® BZ-54 Tetrabromophthalic anhydride derivative Bromine Content: 54% (This product is not registered for sale in Europe)	Proprietary	800 cps @ 25°C 5% @ 211°C 10% @ 226°C 50% @ 268°C 95% @ 291°C	1.7		Water Dichloromethane Toluene Methanol MEK <0.1 C C 5.7 C
Firemaster® 600 Tetrabromobenzoate ester composition Bromine Content: 27% Phosphorus Content: 4% (This product is not registered for sale in Europe)	Proprietary Blend	200 cps @ 25°C 5% @ 210°C 10% @ 226°C 25% @ 249°C 50% @ 269°C	1.4		Water Dichloromethane Toluene Methanol MEK <0.1 C 9.47 C C

	Viscosity/ Melting Range °C	Volatility TGA, Wt. Loss @ Temp	Typical Specific Gravity	Bulk Density g/ml	Solubility (g/100 g solvent @ 25 °C)
Firemaster® 602 Tetrabromobenzoate ester composition Bromine Content: 27% Phosphorus Content: 4% (This product is not registered for sale in Europe)	Proprietary Blend 200 cps @ 25°C	5% @ 217°C 10% @ 234°C 25% @ 257°C 50% @ 279°C	1.4		Water Dichloromethane Toluene Methanol MEK <0.1 C 9.40 C C
BC-52™ Phenoxy-terminated carbonate oligomer of Tetrabromobisphenol A Formula Weight: ~2,500 Bromine Content: 52%	Proprietary CAS No. 94334-64-2	180-210 5% @ 408°C 10% @ 438°C 50% @ 480°C	2.2	0.61 (L) 1.00 (P)	Water Dichloromethane Toluene Methanol MEK <0.1 C 14 <0.1 C
BC-58™ Phenoxy-terminated carbonate oligomer of Tetrabromobisphenol A Formula Weight: ~3,500 Bromine Content: 58%	Proprietary CAS No. 71342-77-3	200-230 5% @ 380°C 10% @ 423°C 50% @ 475°C	2.2	0.66 (L) 1.02 (P)	Water Dichloromethane Toluene Methanol MEK <0.1 C 14 <0.1 C
Firemaster® 2100R Decabromodiphenyl ethane Formula Weight: 971.2 Bromine Content: 81-82%	 CAS No. 84852-53-9	348-353 1% @ 314°C 5% @ 344°C 50% @ 402°C 90% @ 423°C	3.2	1.19 (L) 1.39 (P)	Water Dichloromethane Toluene Methanol MEK <0.01 <0.01 <0.01 <0.01 <0.01
PH-73FF™ 2,4,6-Tribromophenol Formula Weight: 330.8 Bromine Content: 72.5%	 CAS No. 118-79-6	91-95 5% @ 122°C 10% @ 134°C 50% @ 167°C 95% @ 183°C	2.2	1.4 (L) 1.41 (P)	Water Dichloromethane Toluene Methanol MEK <0.1 36 50 84 225

Notes:
TGA: 10 mg @ 10°C/min., N₂
Bulk Density:
L denotes loose
P denotes packed
Solubility:
C denotes complete solubility (100 g/100 ml)
P denotes partial solubility

Phosphorus-Based Flame Retardants

		Viscosity/ Melting Range °C	Volatility TGA, Wt. Loss @ Temp	Typical Specific Gravity	Bulk Density g/ml	Solubility (g/100 g solvent @ 25 °C)
Emerald Innovation® NH-1 Phosphorus Content: 7.9%	Proprietary	72-74 mm ² /s @20°C	5% @ 228°C 10% @ 244°C 50% @ 290°C	1.13		Water Dichloromethane Toluene Methanol MEK <0.1 C C C C
Reofos® 35 Triaryl Phosphates Isopropylated Phosphorus Content: 8.6%	 CAS No. 68937-41-7	42-47 mm ² /s @25°C	5% @ 217°C 10% @ 235°C 50% @ 287°C	1.18		Water Dichloromethane Toluene Methanol MEK Insoluble C C C C
Reofos® 50 Triaryl Phosphates Isopropylated Phosphorus Content: 8.4%	 CAS No. 68937-41-7	53-64 mm ² /s @25°C	5% @ 216°C 10% @ 235°C 50% @ 284°C	1.17		Water Dichloromethane Toluene Methanol MEK Insoluble C C C C
Reofos® LF-50 Triaryl Phosphates isobutylenated Phosphorus Content: 8.4%	 CAS No. 68937-40-6	47-58 mm ² /s @25°C	5% @ 242°C 10% @ 258°C 50% @ 307°C	1.17-1.19		Water Dichloromethane Toluene Methanol MEK Insoluble C C C C
Reofos® 65 Triaryl Phosphates Isopropylated Phosphorus Content: 8.1%	 CAS No. 68937-41-7	64-76 mm ² /ss @25°C	5% @ 212°C 10% @ 229°C 50% @ 285°C	1.16		Water Dichloromethane Toluene Methanol MEK Insoluble C C C C
Reofos® 95 Triaryl Phosphates Isopropylated Phosphorus Content: 7.6%	 CAS No. 68937-41-7	100-114 mm ² /s @25°C	5% @ 222°C 10% @ 241°C 50% @ 296°C	1.14		Water Dichloromethane Toluene Methanol MEK Insoluble C C C C
Kronitex® CDP Cresyl Diphenyl Phosphate Phosphorus Content: 9.1%	 CAS No. 26444-49-5	34-48 mm ² /s @25°C	5% @ 217°C 10% @ 236°C 50% @ 285°C	1.21		Water Dichloromethane Toluene Methanol MEK Insoluble C C C C
Kronitex® TCP Tricresyl Phosphate Phosphorus Content: 8.4%	 CAS No. 1330-78-5	47-68 mm ² /s @25°C	5% @ 222°C 10% @ 239°C 50% @ 289°C 95% @ 323°C	1.17		Water Dichloromethane Toluene Methanol MEK Insoluble C C C C
Kronitex® TXP Trixylyl Phosphate Phosphorus Content: 7.8%	 CAS No. 25155-23-1	41-46 mm ² /s @40°C	5% @ 232°C 10% @ 250°C 50% @ 298°C	1.14		Water Dichloromethane Toluene Methanol MEK Insoluble C C C C

Notes: TGA: 10 mg @ 10°C/min., N₂ Bulk Density: L denotes loose P denotes packed Solubility: C denotes complete solubility (100 g/100 ml) P denotes partial solubility

Antimony, Synergists & Smoke Suppressants

Antimony Trioxide

	Typical Values:	Antimony Oxide Content (as Sb 2O ₃)	Arsenic content (as As) (max)	Iron content (as Fe) (max)	Lead content (asPb) (max)	Av. Particle size (Typical Values)
TMS® / TIMONOX® RED STAR / FIRESHIELD® H/ THERMOGUARD®S	99.3%	0.25%	0.003%	0.20%	1.0-1.5 µm	
TMS® / TIMONOX® WHITE STAR	99.5%	0.25%	0.003%	0.07%	1.0-1.5 µm	
TMS-HP® / TIMONOX® BLUE STAR POLYMER GRADE / FIRESHIELD® HB / THERMOGUARD® HPM (Products registered in Europe)	99.5%	0.09%	0.003%	0.10%	0.9-1.5 µm	
TRUTINT® 50	99.3%	0.30%	0.005%	0.20%	2.3 µm	
FIRESHIELD® L / THERMOGUARD® L	99.3%	0.30%	0.002%	0.20%	2.0-3.2 µm	
MICROFINE® A05 / MICROFINE® A03 / ULTRAFINE™ II	99.3%	0.30%	0.003%	0.20%	0.3-0.9 µm	

Sodium Antimonate

	Typical Values:	Antimony Oxide Content (as Sb 2O ₃)	Arsenic content (as As) (max)	Iron content (as Fe) (max)	Lead content (as Pb) (max)	Av. Particle size (Typical Values)
PYROBLOC® SAP-2 / THERMOGUARD® FR		60.4	0.09%	0.005%	0.09%	2 µm

Zinc Borate

	Typical Values:	Stoichiometry (°C, % mass loss)	TGA	Av. Particle Size
ZB-223		2ZnO.2B ₂ O ₃ .3H ₂ O	200°C 1% 245°C 5% 285°C 10%	4 µm
ZB-467		4Zn0.6B ₂ O ₃ .7H ₂ O	280°C 1% 380°C 5% 420°C 10%	4 µm

Synergists & Smoke Suppressants

SMOKEBLOC® / BFR Series of products with combined flame retardants and / or afterglow and / or smoke suppressing properties. Used as partial or complete replacement for antimony oxide in PVC formulations.

ONGARD® 2 (Available in Europe) Proprietary Zinc/Magnesium Complex, effective smoke suppressant for PVC with excellent heat aging properties. Cost effective antimony oxide replacement for stringent rigid PVC applications.

THERMOGUARD® CPA Flame retardant synergists for PVC with low smoke performance. Used as partial or complete replacement for antimony oxide in PVC applications.



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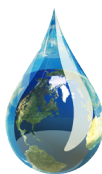
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The information contained herein is correct to the best of our knowledge. Your attention is directed to the pertinent Material Safety Data Sheets for the products mentioned herein.

All sales are subject to Chemtura's standard terms and conditions of sale, copies of which are available upon request and which are part of Chemtura's invoices and/or order acknowledgements. Except as expressly provided in Chemtura's standard terms and conditions of sale, no warranty, express or implied, including warranty of merchantability or fitness for a particular purpose, is made with respect to the products described herein. Nothing contained herein shall constitute permission or recommendation to practice any invention covered by a patent without a license from the owner of the patent.



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Good Chemistry at Work

Responsible Care® is a registered service mark of the American Chemistry Council, Inc. Chemtura is dedicated to Responsible Care®, the chemical industry's initiative to protect the environment; ensure the safety and security of our operations; and safeguard the health and safety of our employees and neighboring communities. Our goal is to make continuous progress toward the vision of no accidents, injuries or harm to the environment. As active and responsible members of the communities in which we operate, Chemtura is committed to open communication with our employees and neighbors. We monitor the safe production, transportation and use of our products. Our employees are comprehensively trained to do their jobs safely and with minimum impact on the environment. We care about the future — for all of us. If you have any questions, or would like to comment on our Responsible Care program, please send an email to RCMS@chemtura.com.