



Zinflam[®]

Zinc borate

Flame retardants
and smoke
suppressants



Larderello Group

Italian tradition, global horizons. Since 1818.

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Physical-chemical specification

Chemical name	Zinc borate
Formula	$2\text{ZnO} \cdot 3\text{B}_2\text{O}_3 \cdot 3.5\text{H}_2\text{O}$
Molecular weight	434.7
Description	Fine powder
CAS	138265-88-0
EINECS	215-566-6 (anhydrous form)

Characteristics	Units	Specification values	
		min	max
Aspect	--	Fine powder	
Colour	--	White	
Boric oxide B_2O_3	%	46.5	49.5
Zinc oxide ZnO	%	37.0	39.0
Crystallization water H_2O	%	11.5	16.5
Moisture	%	--	1.0
Volatile loss 24 hours to 120°C	%	--	1.0
Bulk density	g/ml	0.7	1.0
Weight loss 950°C	%	--	15.5
Approx. dehydration temperature	°C	290	
Refractive index	--	1.57	
Crystal density	g/cm^3	2.8	
Oil absorption	% w/w	24	
Water solubility	% w/w	0.1	

Heavy metals				
ZINFLAM® HP	Lead	ppm	--	5.0
	Cadmium	ppm	--	3.0

Particle size distribution				
ZINFLAM® ZINFLAM® HP	>5 μm	%	--	50
	>15 μm	%	--	10
	>25 μm	%	--	1
ZINFLAM® fine	>3 μm	%	--	50
	>6 μm	%	--	10
	>10 μm	%	--	1
ZINFLAM® extra fine	>2 μm	%	--	50
	>4 μm	%	--	10
	>7 μm	%	--	1

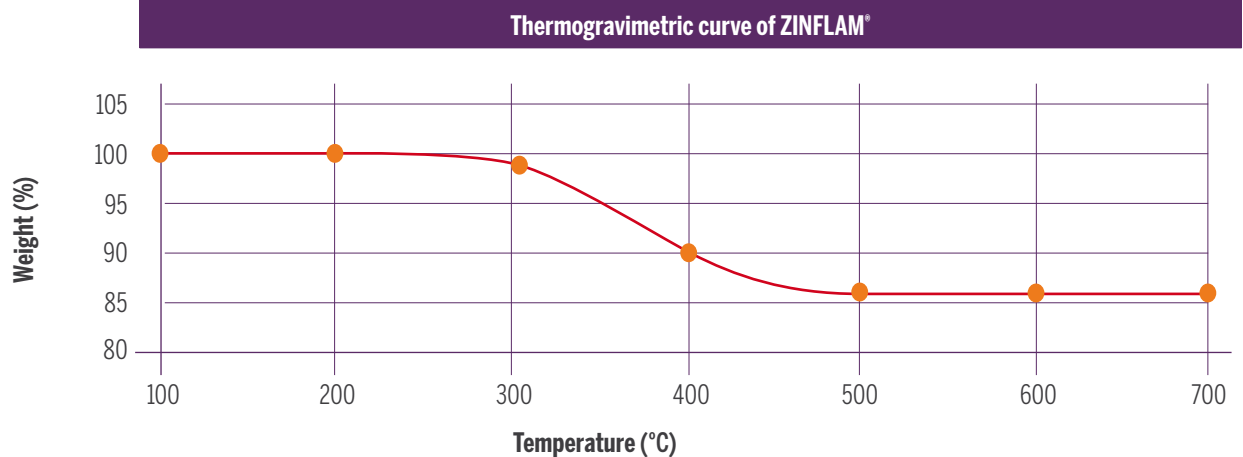
Properties

ZINFLAM® is a zinc borate synthetic product. It is a boron based fire-retardant, insoluble in water, alcohol, benzene and acetone, easy soluble in hydrochloric acid, sulphuric acid and dimethyl sulfoxide.

His refractive index is 1.57, similar to that of many polymeric matrices allowing the use of lower charges of pigments.

ZINFLAM® acts as a multifunctional flame retardant:

- It promotes the formation of a protective vitreous layer and of a strong char layer, which prevents the oxidation of carbon by limiting the available oxygen and suppresses smoke production.
- It loses its water of hydration at temperatures above 290°C, cooling the front of the flames and subtracting energy to the fire with an endothermic reaction.



- It acts as a synergist in conjunction with halogenated compounds, so that lower loadings of halogenated flame retardant additives are needed, in this way reducing the formation of corrosive smokes during fire.
- Its strong synergic effect with antimony trioxide allows sensible savings due the higher costs of antimony trioxide. In presence of alumina trihydrate (ATH), the synergic effect is enhanced even at lower charges of additives.
- It provides an improved resistance against electrical degradation: high anti-arcing and anti-tracking indexes.
- It is an afterglow suppressant.

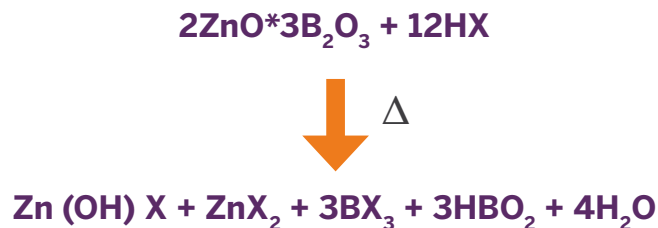
Action mechanism

At temperatures above 290°C, ZINFLAM® loses all its water of hydration cooling the flame and subtracting energy to the burning process.

At higher temperatures, ZINFLAM® separates in an almost pure phase of fused B₂O₃, which forms a vitreous protective layer on the surface of the flammable substratum, and in a phase of ZnO.

The Zinc species and the boric acid catalyze reactions of dehydration in the solid phase, favouring carbonization processes and the formation of a strong char, which prevents the emission of further flammable gasses from the substrate subtracting burning fuel to the flame. The strong char formed hinders the formation of smoke; in some matrices the use of ZINFLAM® causes a smoke suppression of almost 40% compared to the use of antimony trioxide alone.

In halogenated matrices or in conjunction with halogenated additives, ZINFLAM® reacts with the halogens, forming volatile compounds of boron and zinc:



The volatile Zn(OH)X and ZnX₂ are likely to react with the free radicals, interfering in the radical chain reaction of fire propagation.

The gaseous BX₃ and H₂O dilute the combustible gasses released by the burning matrix and cool the flame, subtracting further energy to the fire.

The strong synergic effect shown with antimony trioxide is probably due to the fact that the action of antimony trioxide is largely confined to the gas phase, while ZINFLAM® acts in the condensed phase too.



Application data

1. PVC

Although PVC naturally meets most flammability requirements, the need to meet increasingly more demanding national fire classifications necessitates the addition of flame retarders. ZINFLAM® is largely used in PVC formulations due to its strong synergic effect with antimony trioxide.

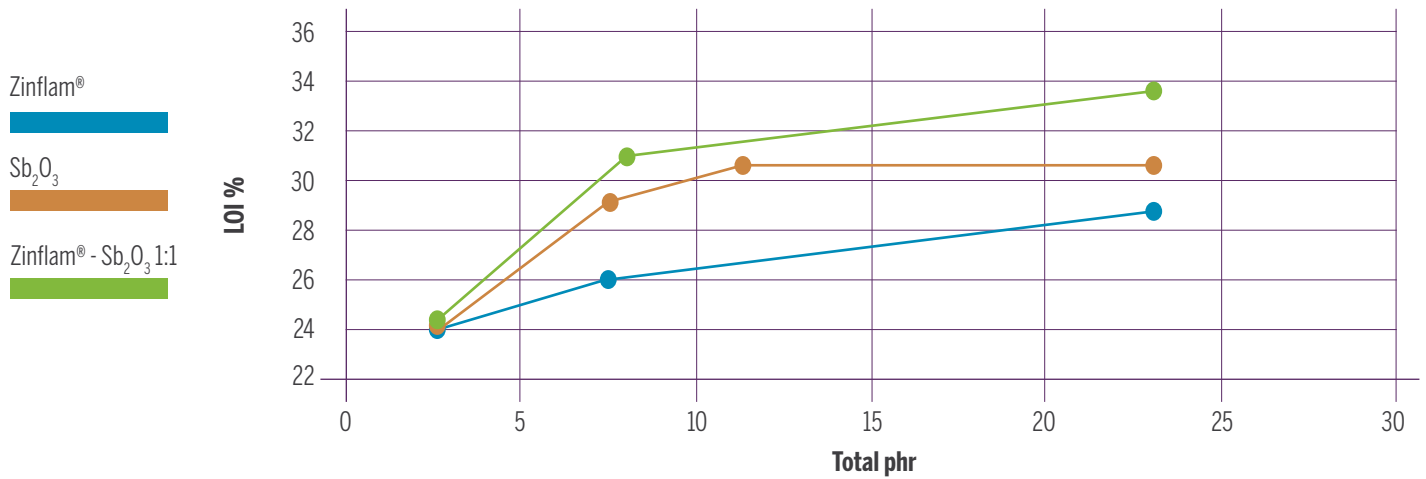
Application	Possible Formulations		
Wires / Cables	PVC	100	parts
	Zinflam®	3-5	phr
	Sb ₂ O ₃	3-5	phr
	Alumina trihydrate	15-20	phr
	Plasticizers	30-40	phr
	Epoxy co-stabilizer	3-5	phr
	Stabilizers	0.5-7	phr
Auto / Train upholstery	PVC	100	parts
	Zinflam®	1.5-2.5	phr
	Sb ₂ O ₃	1.5-2.5	phr
	Plasticizerse	60-80	phr
	Epoxy co-stabilizer	3-5	phr
	Stabilizers	3	phr
	Functional fillers	30-60	phr
Wall covering	PVC	100	parts
	Zinflam®	5-10	phr
	Sb ₂ O ₃	2-4	phr
	Alumina trihydrate	10-15	phr
	Plasticizers	45	phr
	Stabilizers	3-5	phr
	Functional fillers	40	phr
Wall covering	PVC	100	parts
	Zinflam®	5-10	phr
	Sb ₂ O ₃	5-10	phr
	Plasticizers	60	phr
	Stabilizers	3	phr
	Epoxy co-stabilizer	3-5	phr
	Functional fillers	10	phr



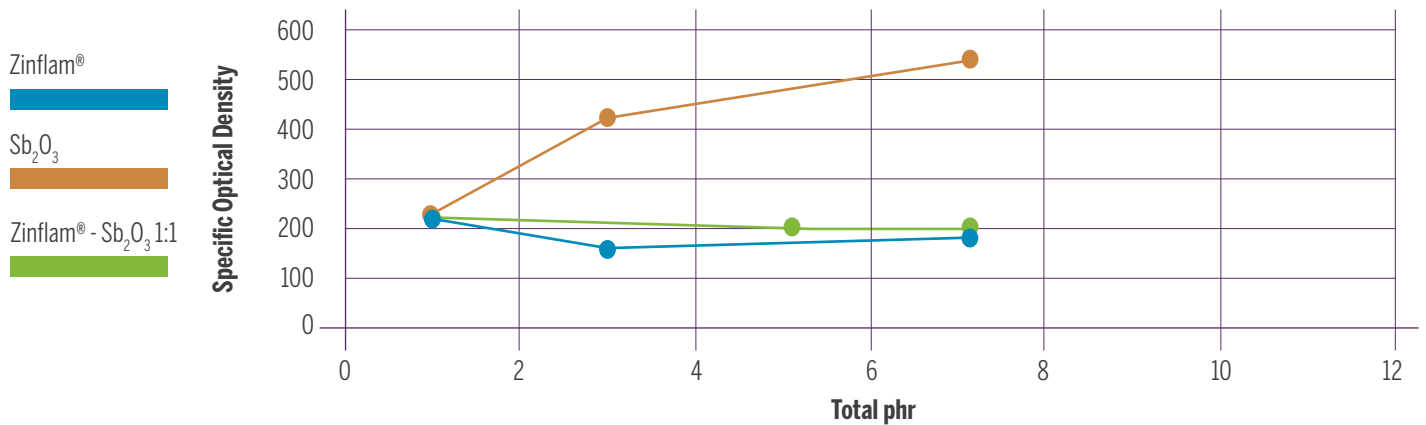
ZINFLAM® replaces 30-60% of the more expensive Sb_2O_3 permitting good savings. Furthermore its refractive index of 1.57 allows the use of lower pigment loading. In the case of halogenated polymers, the smoke suppressing and char forming capability of ZINFLAM® is very important to control the production of corrosive and caustic fumes during the fire, avoiding expensive damage to precious electronic equipments and favouring the escape of people involved in the fire.

ZINFLAM® shows best results in smoke suppression and flammability control when used in conjunction with $Al(OH)_3$ or $Mg(OH)_2$ and Sb_2O_3 .

Synergism with Sb_2O_3



Smoke emission



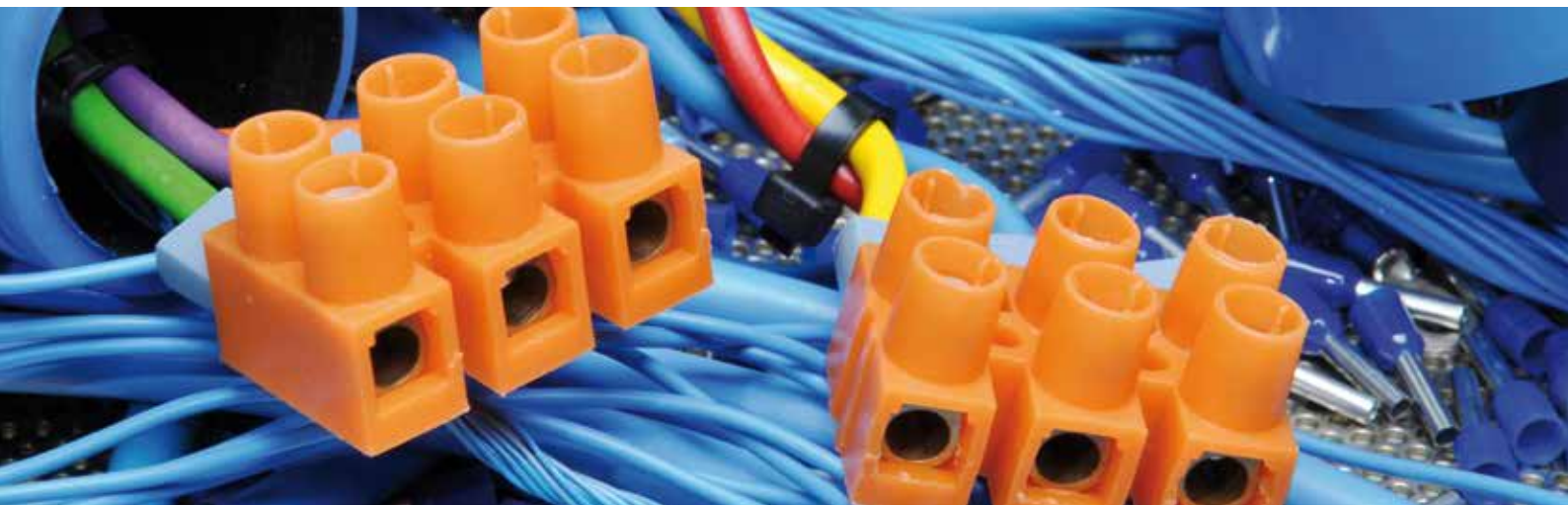
2. Polyamides

Polyamides are used in electronic components and in similar devices under a high risk of ignition, so the use of flame retardant additives is almost a necessity. In polyamides processed at temperatures above 300°C, ZINFLAM® furnishes a good fire retardancy protection and improves resistance against electrical degradation.

As known, ZINFLAM® has a high synergic effect with halogenated flame retardants so it is easily used in combination with the brominated flame retardants usually processed in polyamides.

ZINFLAM® can be used in both halogenated and halogen free systems, furnishing burning drips prevention and limiting after-glow. In some application ZINFLAM® can totally replace antimony trioxide, allowing good savings.

Application	Possible formulations	
Nylon 6,6 (PA66) reinforced	Nylon 6,6	45 - 63 %
	Zinflam®	3 - 18 %
	Sb ₂ O ₃	0 - 2.5 %
	Fiberglass	15 - 30 %
	Functionalized coupling agent	10 - 25 %
Nylon 6,6 (PA66) not reinforced	Nylon 6,6	75 - 80 %
	Zinflam®	3 - 5 %
	Sb ₂ O ₃	1 - 2 %
	Halogenated flame retarder	15 - 18 %
Nylon 6 reinforced	Nylon 6	50 - 60 %
	Zinflam®	2 - 7 %
	Sb ₂ O ₃	0 - 5 %
	Fiberglass	15 - 25 %
	Functionalized coupling agent	15 - 20 %
Nylon 6 not reinforced	Nylon 6	75 - 80 %
	Zinflam®	2 - 3 %
	Sb ₂ O ₃	2 - 6 %
	Halogenated flame retarder	16 - 18 %



3. Polyolefins

ZINFLAM® is used as a synergist flame retarder in both halogenated and halogen free systems. In halogenated formulations in conjunction with antimony trioxide, in halogen free formulations with alumina trihydrate or magnesium hydroxide.

Its use assures smoke and afterglow suppression, char formation and anti arcing action and can result in an improvement of the elongation properties.

ZINFLAM® replaces up to 50% or more of antimony trioxide, allowing good savings due to the much higher cost of Sb_2O_3 .

Application	Possible formulations		
Ethyl vinyl acetate (cross linked)	EVA	100	phr
	Zinflam®	10 - 50	phr
	Sb_2O_3	30 - 12	phr
	Decabromodiphenyl oxyde	0 - 50	phr
	Cross linking agent	0 - 5	phr
	Antioxidant	0 - 2	phr
Ethyl vinyl acetate (cross linked)	EVA	100	phr
	Zinflam®	10 - 50	phr
	Alumina trihydrate	200	phr
	Cross linking agent	4 - 6	phr
	Stabilizer	0.5 - 3	phr
Polypropylene	Polypropylene	45 - 60	%
	Zinflam®	5 - 7	%
	Sb_2O_3	3 - 8	%
	Talc	0 - 20	%
	Functionalized coupling agent	0 - 35	%
	Decabromodiphenyl oxyde	0 - 15	%
Low density polyethylene (cross linked)	LDPE	100	phr
	Zinflam®	5 - 10	phr
	Sb_2O_3	0 - 10	phr
	Talc	0 - 25	phr
	Functionalized coupling agent	10 - 60	phr
	Decabromodiphenyl oxyde	0 - 20	phr
	Cross linking agent	2	phr
	Antioxidant	0.5 - 1	phr
Low density polyethylene	LDPE	100	phr
	Zinflam®	5	phr
	Sb_2O_3	10	phr
	Decabromodiphenyl oxyde	30	phr
	Talc	25	phr
Ultra low density polyethylene (halogen free)	ULDPE	100	phr
	Zinflam®	10	phr
	Magnesium hydroxide	100 - 140	phr
	Silicone	5	phr
	Carbon Black	3	phr

4. Elastomers

ZINFLAM® can be used in both halogenated and non-halogenated formulations, in conjunction with antimony trioxide, alumina trihydrate, magnesium hydroxide, red phosphorus or ammonium polyphosphate.

Its use results in smoke suppression, char formation and after-glow suppression. It furnishes an anti-arcing and anti-tracking action too.

Application	Possible Formulations		
Ethyl vinyl acetate (wires and cables)	EVA	100	phr
	Zinflam®	10 - 20	phr
	Alumina trihydrate	200	phr
Ethylene-propylene Diene monomer rubber (wires and cables, halogen free)	EPDM	100	phr
	Zinflam®	5 - 20	phr
	Mg (OH) ₂	150	phr
	Coupling agent	0 - 2	phr
Ethylene-propylene Diene monomer rubber (wires and cables, halogenated)	EPDM	100	phr
	Zinflam®	5 - 20	phr
	Sb ₂ O ₃	5	phr
	Decabromodiphenylether	30	phr
Styrene-butadiene rubber (beltings)	LDPE	100	phr
	Zinflam®	10 - 12	phr
	Sb ₂ O ₃	3 - 8	phr
	Talc	3 - 20	phr
	Functionalized coupling agent	10 - 20	phr
	Decabromodiphenyl oxyde	30 - 70	phr
Neoprene (beltings)	Neoprene	100	phr
	Zinflam®	10 - 15	phr
	Sb ₂ O ₃	5	phr
	Mg (OH) ₂	15	phr
	Stabilizers - fillers	50 - 60	phr
Neoprene (coatings)	Neoprene	100	phr
	Zinflam®	10	phr
	Sb ₂ O ₃	10	phr
	Alumina trihydrate	30	phr
	Stabilizers - fillers	25	phr
	Coupling agent	15 - 20	phr



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