Flame retardants and smoke suppressants

Since 1818 Boron Producers

Società Chimica Larderello SCL

®Zinborel

Zinc Borate

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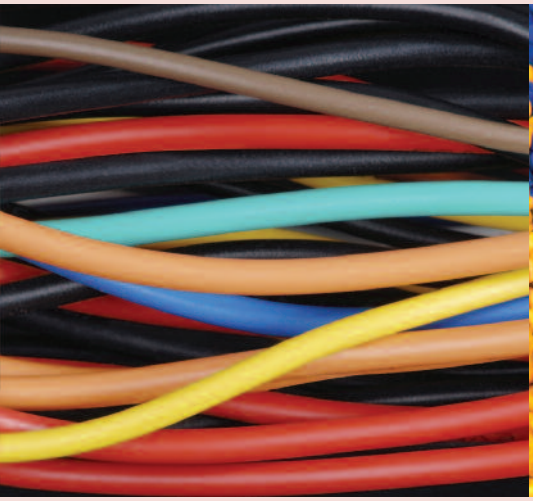
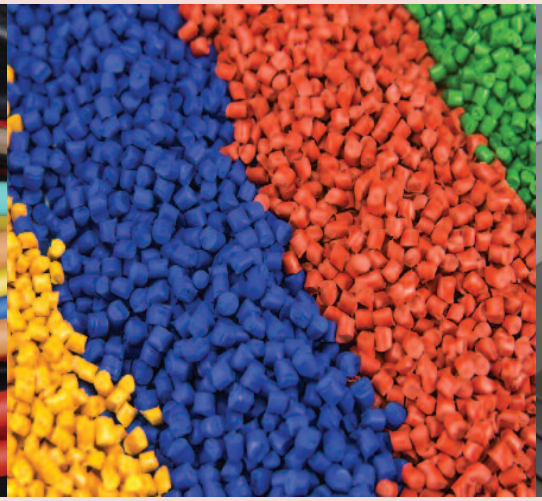




®Zinborel

Zinc Borate

Physical-Chemical Specification

Chemical name	Zinc Borate
Formula	$2ZnO \bullet 3B_2O_3 \bullet 3.5H_2O$
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				
ZINBOREL® HP	Lead	ppm	--	5.0
	Cadmium	ppm	--	3.0
Particle Size Distribution				
ZINBOREL® ZINBOREL® HP	>5 µm	%	--	50
	>15 µm	%	--	10
	>25 µm	%	--	1
ZINBOREL® Fine	>3 µm	%	--	50
	>6 µm	%	--	10
	>10 µm	%	--	1
ZINBOREL® Extra Fine	>2 µm	%	--	50
	>4 µm	%	--	10
	>7 µm	%	--	1

Properties

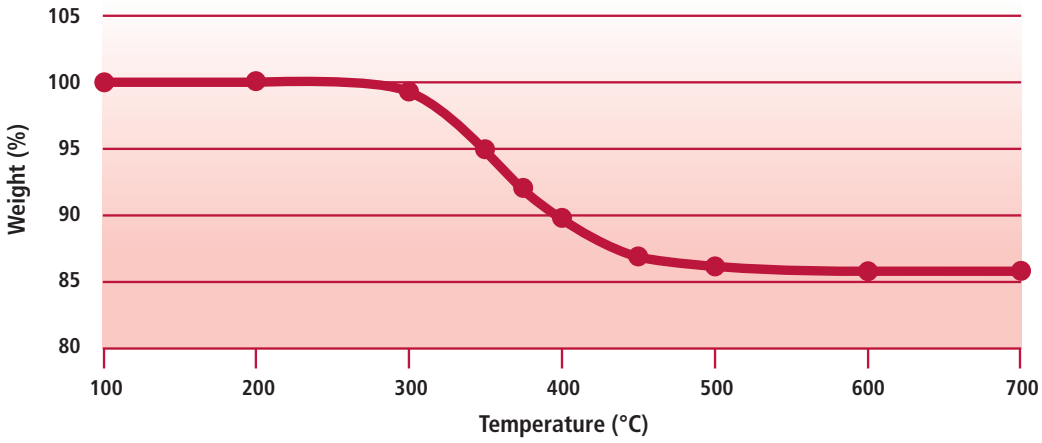
ZINBOREL® is a zinc borate synthetic product. It is a boron based fire-retardant, insoluble in water, alcohol, benzene and acetone, easy soluble in hydrochloric acid, sulphuric acid and dimethyl sulfoxide.
His refractive index is 1.57, similar to that of many polymeric matrices allowing the use of lower charges of pigments.

ZINBOREL® 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 oxigen and suppresses smoke production

- It looses 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

Thermogravimetric Curve of ZINBOREL



- 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, ZINBOREL® looses all its water of hydration cooling the flame and subtracting energy to the burning process.
At higher temperatures, ZINBOREL® separates in an almost pure phase of fused B_2O_3, 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 ZINBOREL® causes a smoke suppression of almost 40% compared to the use of antimony trioxide alone.
In halogenated matrices or in conjunction with halogenated additives, ZINBOREL® reacts with the halogens, forming volatile compounds of boron and zinc:

$$2ZnO*3B_2O_3 + 12HX \xrightarrow{\Delta} Zn(OH)X + ZnX_2 + 3BX_3 + 3HBO_2 + 4H_2O$$

The volatile Zn (OH)X and ZnX_2 are likely to react with the free radicals, interfering in the radical chain reaction of fire propagation.
The gaseous BX_3 and H_2O 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 ZINBOREL® acts in the condensed phase too.

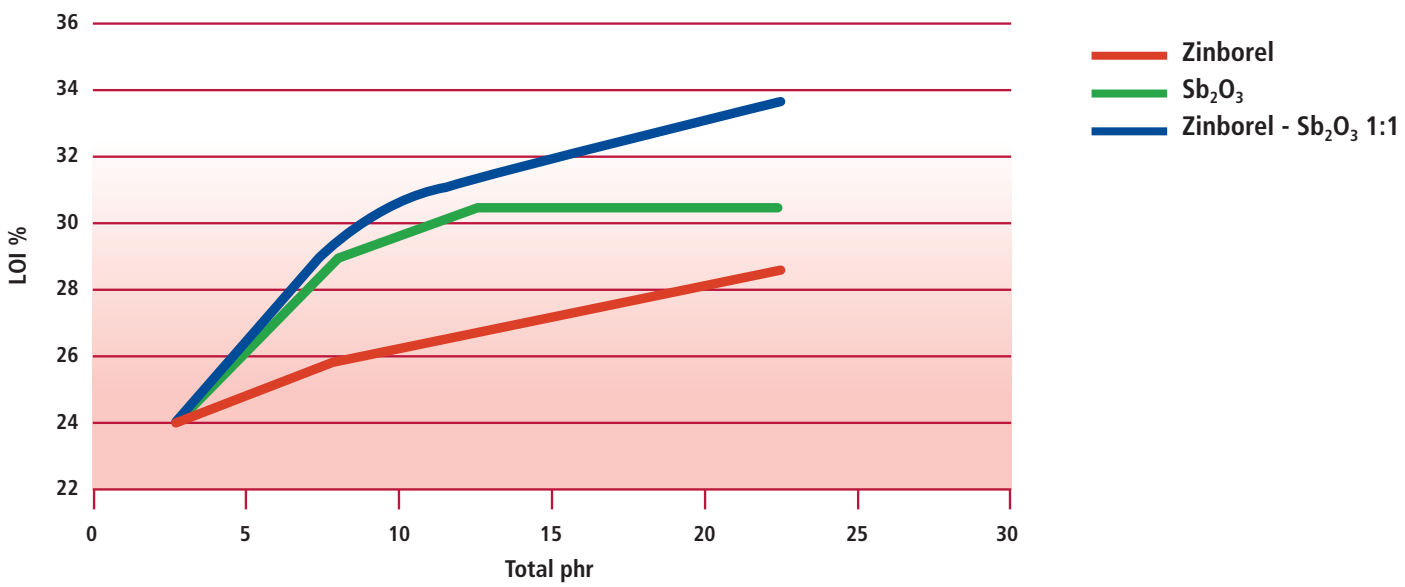
PVC

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

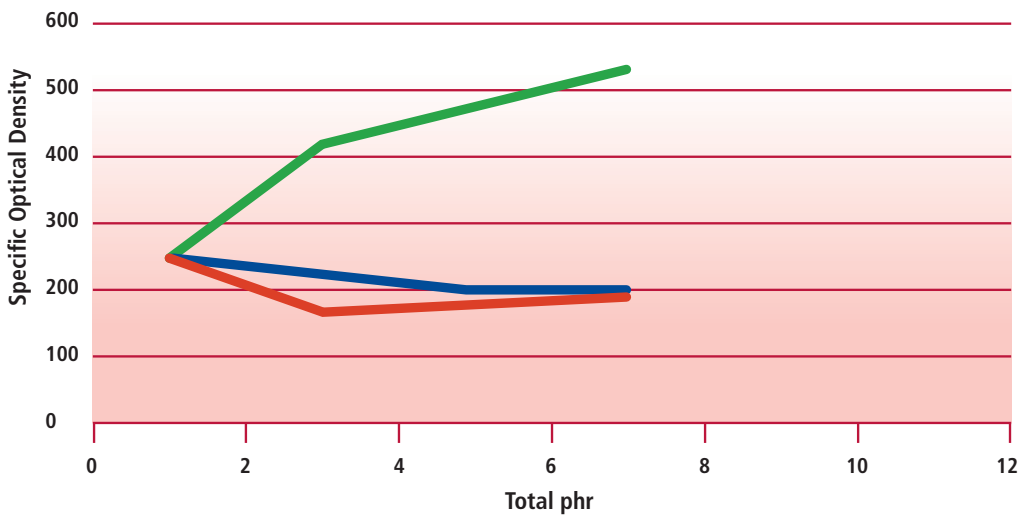
Application	Possible Formulations	
Wires / Cables	PVC	100 parts
	Zinborel®	3 - 5 phr
	Sb_2O_3	3 - 5 phr
	Alumina trihydrate	15 - 20 phr
	Plasticizers	30 - 40 phr
	Epoxy co-stabilizer	3 - 5 phr
	Stabilizers	0.5 - 7 phr
Auto / Train upholstery	PVC	100 parts
	Zinborel®	1.5 - 2.5 phr
	Sb_2O_3	1.5 - 2.5 phr
	Plasticizers	60 - 80 phr
	Epoxy co-stabilizer	3 - 5 phr
	Stabilizers	3 phr
	Functional Fillers	30 - 60 phr
Wall covering	PVC	100 parts
	Zinborel®	5 - 10 phr
	Sb_2O_3	2 - 4 phr
	Alumina trihydrate	10 - 15 phr
	Plasticizers	45 phr
	Stabilizers	3 - 5 phr
	Functional Fillers	40 phr
Coated fabrics / films	PVC	100 parts
	Zinborel®	5 - 10 phr
	Sb_2O_3	5 - 10 phr
	Plasticizers	60 phr
	Stabilizers	3 phr
	Epoxy co-stabilizer	3 - 5 phr
	Functional Fillers	10 phr

ZINBOREL® replaces30-60% 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 ZINBOREL® 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.
ZINBOREL® 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



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, ZINBOREL® furnishes a good fire retardancy protection and improves resistance against electrical degradation.
As known, ZINBOREL® has an high synergic effect with halogenated flame retardants so it is easily used in combination with the brominated flame retardants usually processed in polyamides.
ZINBOREL® can be used in both halogenated and halogen free systems, furnishing burning drips prevention and limiting after-glow. In some application ZINBOREL® can totally replace antimony trioxide, allowing good savings.

Application	Possible Formulations	
Nylon 6,6 (PA66) reinforced	Nylon 6,6	45 - 63 %
	Zinborel®	3 - 18 %
	Sb_2O_3	0 - 2.5 %
	Fiberglass	15 - 30 %
	Functionalized coupling agent	10 - 25 %
Nylon 6,6 (PA66) not reinforced	Nylon 6,6	75 - 80 %
	Zinborel®	3 - 5 %
	Sb_2O_3	1 - 2 %
	Halogenated flame retarder	15 - 18 %
Nylon 6 reinforced	Nylon 6	50 - 60 %
	Zinborel®	2 - 7 %
	Sb_2O_3	0 - 5 %
	Fiberglass	15 - 25 %
	Functionalized coupling agent	15 - 20 %
Nylon 6 not reinforced	Nylon 6	75 - 80 %
	Zinborel®	2 - 3 %
	Sb_2O_3	2 - 6 %
	Halogenated flame retarder	16 - 18 %

ZINBOREL® 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.
ZINBOREL® 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 Vinil Acetate (cross linked)	EVA	100 phr
	Zinborel®	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 Vinil Acetate (cross linked, halogen free)	EVA	100 phr
	Zinborel®	10 - 50 phr
	Alumina trihydrate	200 phr
	Cross linking agent	4 - 6 phr
	Stabilizer	0.5 - 3 phr
Polypropylene	Polypropylene	45 - 60 %
	Zinborel®	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
	Zinborel®	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
	Zinborel®	5 phr
	Sb_2O_3	10 phr
	Decabromodiphenyloxyde	30 phr
	Talc	25 phr
Ultra Low Density Polyethylene (halogen free)	ULDPE	100 phr
	Zinborel®	10 phr
	Magnesium hydroxide	100 - 140 phr
	Silicone	5 phr
	Carbon Black	3 phr

Application data

Elastomers

ZINBOREL can be used in both halogenated and non-halogenated formulations, in conjunc-tion 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 Vinil Acetate (wires and cables)	EVA	100 phr
	Zinborel®	10 - 20 phr
	Alumina trihydrate	200 phr
Ethylene-Propylene Diene Monomer Rubber (wires and cables, halogen free)	EPDM	100 phr
	Zinborel®	5 - 20 phr
	Mg $(OH)_2$	150 phr
	Coupling agent	0 -2 phr
Ethylene-Propylene Diene MonomerRubber (wires and cables, halogenated)	EPDM	100 phr
	Zinborel®	5 - 20 phr
	Sb_2O_3	5 phr
	Decabromodiphenylether	30 phr
Styrene-Butadiene Rubber (beltings)	SBR	100 phr
	Zinborel®	10 - 12 phr
	Sb_2O_3	3 - 8 phr
	Plasticizers	3 - 20 phr
	Functionalized coupling agent	10 - 20 phr
	Stabilizers - Fillers	30 - 70 phr
Neoprene (beltings)	Neoprene	100 phr
	Zinborel®	10 - 15 phr
	Sb_2O_3	5 phr
	Mg(OH)2	15 phr
	Stabilizers - Fillers	50 - 60 phr
Neoprene (coatings)	Neoprene	100 phr
	Zinborel®	10 phr
	Sb2O3	10 phr
	Alumina trihydrate	30 phr
	Stabilizers - Fillers	25 phr
	Coupling agent	15 - 20 phr

Notes



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