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## Commercially Available Halogen free Alternatives to Halogen-Containing Flame Retardant Systems in Polymers

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### 1 Overview of flame retardants by polymer

This table gives an overview of commercially available non halogenated flame retardants. Often, combinations of the given substances, which may have synergistic effects, are used. They are not specified here, as the individual formulation is up to the polymer compounder and often regarded as company know how. The abbreviations are listed at the end of the document. Please send any comments or information on new FRs and applications to [jtroitzsch@troitzsch.com](mailto:jtroitzsch@troitzsch.com).

Polymer	Application / Product	Fire Safety Requirement	Halogen-Containing FR System	Halogen free FR System
<b>Thermoplastics</b>				
PE	E&E	UL94V0	Deca / ATO DBDE / ATO EBTPI / ATO TBNPP / ATO	Intum P/N P-red/HFR P-red
	Building Films DE	UL94V2	CP / ATO	
		DIN4102B2	TBNPP / ATO DBDE / ATO	NorHals,NOW Org-P and PCO
	Wire & Cable	IEC 60332-3		ATH
E / EVA	Wire & Cable	IEC 60332-3		ATH/Nano
PP	E&E	UL94V0	Deca / ATO	Intum P/N
			DBDE / ATO	MOH
			EBTPI / ATO	
			TDPE / ATO	
			BEO / ATO	
			CP / ATO	

Polymer	Application / Product	Fire Safety Requirement	Halogen-Containing FR System	Halogen free FR System
		UL94V2	HBCD / ATO TBNPP	
	Building Pipes DE	DIN4102B1	TDPE	
	Building Films DE	DIN4102B2	BEO / ATO	Intum P/N
	Building FR	NFP92507 M2		
	Wire & Cable	IEC 60332-3	TBNPP / ATO	ATH or MOH
HIPS	E&E	UL94V0	Deca / ATO DBDE / ATO EBTPI / ATO BEO / ATO TBBPA / ATO CP / ATO	
		UL94V2	HBCD	RDP TPP BDP PolyDP
EPS/XPS	Building foam DE	DIN4102B1	HBCD, BrPM	
ABS	E&E	UL94V0	Deca / ATO DBDE / ATO EBTPI / ATO BEO / ATO TBBPA / ATO	
PA	E&E	UL94V0	Dech / ATO PBBPA / ATO BrPS / ATO BEO / ATO	P-red MC MPP MePh MeHp MOH AIO(OH) Mel-Me-P
PET	E&E	UL94V0	Deca / ATO DBDE / ATO BEO / ATO EBTPI / ATO TBBPA-CO / ATO	P-red MePh
	Fibres	BS5852Crib5		Dopo PPhos

Polymer	Application / Product	Fire Safety Requirement	Halogen-Containing FR System	Halogen free FR System
PBT	E&E	UL94V0	Deca / ATO DBDE / ATO EBTPI / ATO BEO / ATO TBBPA-CO / ATO	MePh MeI-Me-P
PC	E&E	UL94V0	Deca / ATO DBDE / ATO EBTPI TBBPA-CO / ATO TBBPA reactive	SulSalts TPP RDP BDP FRX
PC / ABS	E&E	UL94V0	Deca / ATO DBDE / ATO EBTPI / ATO TBBPA-CO / ATO BEO / ATO	RDP BDP TPP FRX
PPE / HIPS	E&E	UL94V0	Deca / ATO DBDE / ATO EBTPI / ATO TBBPA-CO / ATO	RDP BDP TPP
<b>Thermosets</b>				
EP	E&E	UL94V0	Deca / ATO DBDE / ATO EBTPI / ATO	ATH ATH / APP P-red PhPol
		FR4	TBBPA reactive	PhPol Dopo MePh PhPho Dopo
	Transport Air			
PIRrig	Building DE Building FR Building DE	DIN4102B1 NF P 92501 M1 DIN4102B2	BrPol / TCPP P-red / TCPP	P-red APP
PURrig	Building DE	DIN4102B2 and SBI Class C	BrPol / TCPP	APP PhPol TEP

Polymer	Application / Product	Fire Safety Requirement	Halogen-Containing FR System	Halogen free FR System
				DMPP P-red
	Building USA	ASTM E84	BrPol / TCPP	
PURflex	Transport Auto	MVSS 302	TCPP BrPol	PhPol CDP TCP APP Intum P/N
	Transport Air	KerosBurner	TCPP / Mel / EG	
	Building UphFur UK	BS5852Crib5	TCPP / Mel	
	USA	CalTB117	TCPP / Mel	APP/Mel/EG PhPol CDP TCP
UP	E&E	UL94V0	Deca / ATO DBPE / ATO EBTPI / ATO TBBPA reactive CP / ATO HET-acid TCPP	ATH ATH / P-red ATH / APP DMPP DMPP+WMP
	Transport Sea	Flame Spread		ATH
	Transport Rail DE	DIN 5510		APP
<b>Thermoplastic elastomers</b>				
TPE-E	Wire & Cable	VW 1	Deca / ATO DBPE / ATO EBTPI / ATO	MC MePh FRX
TPE-S	E&E	UL94V0	Deca / ATO DBPE / ATO EBTPI / ATO	Intum P/N
TPU	E&E	UL94V0	Deca / ATO DBPE / ATO EBTPI / ATO TCPP / MC	MC EG CDP RDP BDP MOH MePh
	Wire & Cable	VW1		MePh

Polymer	Application / Product	Fire Safety Requirement	Halogen-Containing FR System	Halogen free FR System
TPO	E&E	UL94V0	Deca / ATO DBPE / ATO	

## 2 Abbreviations

### Applications

UphFur	Upholstered furniture
E&E	Electrical & electronic equipment
Transport	Transportation
- Air	Aircraft
- Auto	Automotive
- Rail	Railways
- Sea	Ships

### Polymers

#### 2.1 Thermoplastics

ABS	Acrylonitrile/butadiene/styrene terpolymer
EPS	Expandable polystyrene
HIPS	High impact polystyrene
PA	Polyamide
PBT	Polybutylene terephthalate
PC	Polycarbonate
PC/ABS	Polycarbonate/ABS blend
PE	Polyethylene
PET	Polyethylene terephthalate
PP	Polypropylene
PPE/HIPS	Polyphenylene ether/high impact polystyrene blend

#### 2.2 Thermosets

EP	Epoxy resins
PIRrig	Rigid polyisocyanurate foam
PURflex	Flexible polyurethane foam
PURrig	Rigid polyurethane foam
UP	Unsaturated polyester resins

#### 2.3 Thermoplastic elastomers

TPE-E	Thermoplastic polyester elastomers
TPE-S	Thermoplastic styrene-block copolymers
TPO	Thermoplastic polyolefins
TPU	Thermoplastic polyurethanes

## Flame retardants

### Brominated flame retardants

BEO	Brominated epoxies
BrPM	Brominated polymer
BrPS	Brominated polystyrene
BrPol	Brominated polyols
DBDE	Decabromodiphenyl ethane
Deca	Decabromodiphenyl ether
EBTPI	Ethylene bis(tetrabromophthalimide)
HBCD	Hexabromocyclododecane
PBB-PA	Poly(pentabromobenzyl acrylate)
TBBPA	Tetrabromobisphenol-A
TBBPA-CO	TBBPA carbonate oligomer
TBNPP	Tris(bromoneopentyl) phosphate
TDPE	TBBPA (2,3-dibromopropyl ether)

### Chlorinated flame retardants

CP	Chloroparaffin
Dech	Alicyclic chlorinated compound (Dechlorane plus)
HET-acid	Hexachloroendomethylenetetrahydrophthalic acid
TCPP	tris(chloropropyl) phosphate

### Organo phosphorous flame retardants

BDP	Bisphenol A bis(diphenyl phosphate)
CDP	Cresyldiphenyl phosphate
DMPP	Dimethylpropane phosphonate
Dopo	Dihydrooxaphosphaphenanthrene oxide
FRX	Polyphosphonates
MePh	Metal phosphinate
PCO	Organophosphorous and P/N compounds
PhPol	Phosphorous polyol
PhPhos	Phenyl phospholane
PolyDP	Polymeric diphenyl phosphate
RDP	Resorcinol bis(diphenyl phosphate)
TCP	Tricresyl phosphate
TEP	Triethyl phosphate

TPP	Triphenyl phosphate
WMP	Intumescent system based on ethylenediamino phosphate

### **Nitrogen-containing flame retardants**

APP	Ammonium polyphosphate
Intum P/N	Intumescent system based on phosphorous/nitrogen compounds
MC	Melamine cyanurate
Mel	Melamine
Mel-Me-P	Melamine poly aluminium and zinc phosphates
MPP	Melamine polyphosphate
NorHals	N-alkoxy hindered amine
NOW	N-alkoxy hindered amine

### **Inorganic flame retardants**

AIO(OH)	Boehmite
ATH	Aluminium hydroxide
ATO	Antimony trioxide
EG	Expandable graphite
MeHp	Metal hypophosphite
MOH	Magnesium hydroxide
Nano	Nanocomposite based on montmorillonite clays
P-red	Red phosphorous
P-red/HFR	Red phosphorous and halogenfree flame retardant

### **Other**

SulSalts	Sulfonate salts
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