FutureBridge

ALTERNATIVE FLAME RETARDANTS

Beyond Brominated Flame Retardants (BFR)

Pivotal regulatory momentum initiates **$1.5B** shift from brominated flame retardants in the US and EU within 12 to 36 months!

Metal hydroxides and Phosphorus based materials emerge as the most promising alternatives to BFRs

	Metal Hydroxide	Inorganic Phosphorus	Organic Phosphorus	Intumescent materials (IFR)	Inorganic/ Organic Silicon	Nanomaterials
SUB-CLUSTERS	Aluminum Hydroxide Magnesium Hydroxide	Red phosphorus Ammonium polyphosphate Phosphate	Phosphorusesters Phosphorus–nitrogen adjuvants Phosphorus–silicon adjuvants	P-N-Based IFR	SiO2 Additive / Reactive Type MMT/OMMT	Nano-clay Nano-carbon/graphite
PROS & CONS	**Low toxicity,** corrosion, and emission of smoke during processing	Micro-encapsulated red phosphorus is **highly efficient**	**Superior** thermal stability	**Excellent fire protection**, low smoke levels and low toxicity	**Non-toxic**, less smoke, low burning value and slow flame propagation	**Efficient char former** and synergistic behavior with other FRs.
	High filler loading is required	**Poor anti-UV** stability and burning of corrosive and toxic gases	**Poor compatibility** of with resins and inferior mechanical properties	**Inferior mechanical properties** with poor dispersibility in resin matrix	**Inferior processability** and mechanical performance	**Inferior processibility** and unknown environmental effects
TRL STATUS	9	9	9	6-9	3-5	6-9
KEY ENTITIES	Alpha, The R.J. Marshall Company, FARETAR Flame Retardant	CLARIANT, pinfa	ICL, Albemarle, LANXESS, ADEKA, CLARIANT	RDR Technologies, THOR	NIST, NSFC	OSU, FEZA, University of Bolton

Start-up Sparks: Advancing Alternative Technologies Beyond BFRs

Greener Flame Retardants

- Paxymer: Greener Flame Retardant for Polyolefin plastics
- 100% Halogen-Free: Delivered as a master batch and compound, Paxymer is entirely halogen-free.
- Polyolefin Compatibility: Specifically developed for various polyolefins such as PP, PE, EVA, TPE, TPO.
- Versatile Application: Compatible with mineral and intumescent systems (P/N-systems).
- Superior Mechanical Performance: Demonstrates excellent mechanical properties for enhanced efficiency.

Paxymer

Non-Toxic, Non-Leaching Flame Retardants

- Nofia® OL1001 and Nofia OL3001 Oligomers are low molecular weight, reactive flame-retardant additives.
- The oligomers are phosphorus-based additives with phenolic end groups suitable for flame retarding thermoset resins, such as unsaturated polyesters, epoxy, polyurethane and polyurea.

FRX INNOVATIONS

Red Phosphorus Flame Retardants

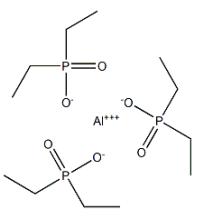
- Shinde offers Red phosphorus flame retardants which contains stabilized and micro-encapsulated fresh red phosphorus powder and polymer resin.
- Red phosphorus demonstrates higher efficiency compared to other flame retardants.
- This flame retardant is widely used in Electronics & Electricals (E&E), automotive, wires and cables, and thermoplastics like PA6, PA66, PBT, PE, PP, EVA, etc.

Shinde Flame Retardant Solution

Corporate drive for change: Embracing advanced chemistries beyond BFRs

Investments in Flame Retardants

CLARIANT

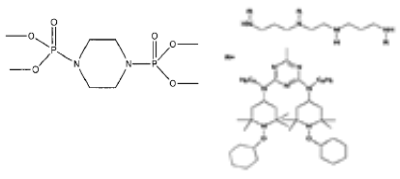


Clariant announces **CHF 40 million** investment in new China flame retardants facility for E-mobility and E&E applications

BASF Partnership in Flame Retardants

THOR

BASF We create chemistry



BASF and GmbH partner to deliver comprehensive **non-halogenated flame-retardant** additives solution

Phosphorus Flame Retardant for Engineering Plastic

LANXESS Energizing Chemistry

LANXESS offers a **phosphorus-based additive** designed for use in glass fiber-reinforced plastics utilized in the manufacturing of electrical and electronic products

Conclusion

- Brand owner companies offer phosphorus-based flame retardants in various forms.
- Nature-derived FRs have recently attracted attentions, but most renewable compounds or natural minerals need to be chemically modified by petrochemicals prior to use.
- Close collaborations among chemists, toxicologists, ecologists, and AI experts is imperative for a thorough and long-term chemical risk assessment of FRs.

About FutureBridge

FutureBridge tracks and advises on the future of industries from a 1-to-25 year perspective.

We keep you ahead on the technology curve, propel your growth, identify new opportunities, markets and business models, answer your unknowns, and facilitate best-fit solutions and partnerships using our platforms, programs, and access to global ecosystems and players.