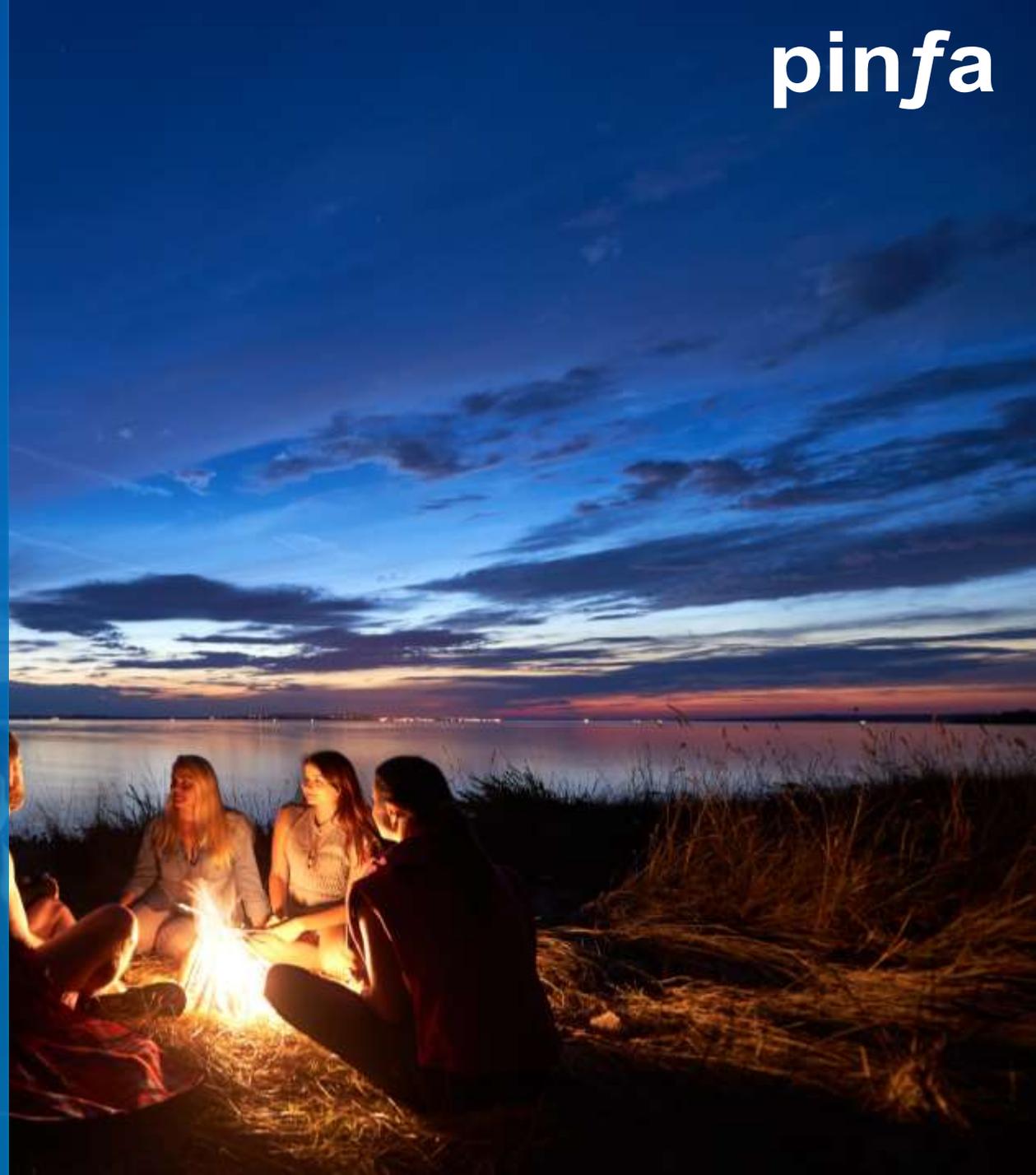


Flame Retardants – answering burning questions ...

Adrian Beard
iNEMI Webinar
23 Oct. 2025

Cefic sector group 



Topics

- Who is pinfa? – Advocating for non-halogenated phosphorus, inorganic, and nitrogen flame retardants
- ECHA's Flame Retardants Strategy and next steps
- Designing Safe and Sustainable-by-Design (SSbD) flame retardants
- Flame retardants and PFAS: navigating complexity
- Engineering challenges: higher voltages, thinner parts, and recyclability



Who is pinfa?

- The **Phosphorus, Inorganic and Nitrogen Flame Retardants Association**.
- Has 28 members: **manufacturers and users** of the three major technologies of non-halogenated flame retardants.
- Established in 2009 as a Sector Group within **Cefic**, the European Chemical Industry Council.
- **pinfa-NA** and **pinfa China**, sister associations, established respectively in 2012 and 2018.
- Mutual membership with **INEMI**¹ and partnership with **GTFI**², **EAPFP**³, **EuroFSA**⁴



(1) *International Electronics Manufacturing Initiative*

(2) *Groupement Technique Français contre l'Incendie*

(3) *European Association for Passive Fire Protection*

(4) *European Fire Safety Alliance*

Pinfa Members: EU, China & North America



Our Mission

- Promote the use of PIN FRs (**P**hosphorus, **I**norganic & **N**itrogen Flame Retardants)
- Provide information to users, legislators and other interested parties on safety, health and environmental issues related to PIN FRs
- Work with industry partners, associations and other stakeholders to support the safety and sustainability of PIN FRs
- Carry out research relevant to safety and sustainability



Europe is very active on chemical regulation

- PFAS
- REACH and CLP (Classification & Labelling)
- ECHA (European Chemicals Agency)
 - Flame Retardants Regulatory Strategy
 - Report on aromatic brominated Flame Retardants (aBFR)
- ESPR (Ecodesign and Sustainable Products Regulation)
 - Substances of Concern (SoC) concept



ECHA Helsinki, ©A. Beard



REACH revision has been postponed several times

- Generic Risk Approach
- Reform of authorisation & restriction
- Registration of (some types of) polymers
- Compliance check of all dossiers / revocation non-compliant dossiers
- Mixture Assessment Factor
- ...
- Will a draft still come in 2025?



AI generated, 2023-10-20



Classification & Labelling: New Hazard classes

New Hazard Classes for:

- Endocrine Disruptors (ED) for human health and environment
 - Persistent Bioaccumulative and Toxic (PBT) and very Persistent and very Bioaccumulative (vPvB)
 - Persistent Mobile and Toxic (PMT) and very Persistent and very Mobile (vPvM)
 - [CLP Delegated Act](#) published 2023-03-31*
 - Guidance documents will be crucial – expected by end of 2023
- More substances will become SVHC



Source: Shutterstock



*COMMISSION DELEGATED REGULATION (EU) 2023/707 of 19 December 2022 amending Regulation (EC) No 1272/2008 as regards hazard classes and criteria for the classification, labelling and packaging of substances and mixtures

ECHA published FR Strategy



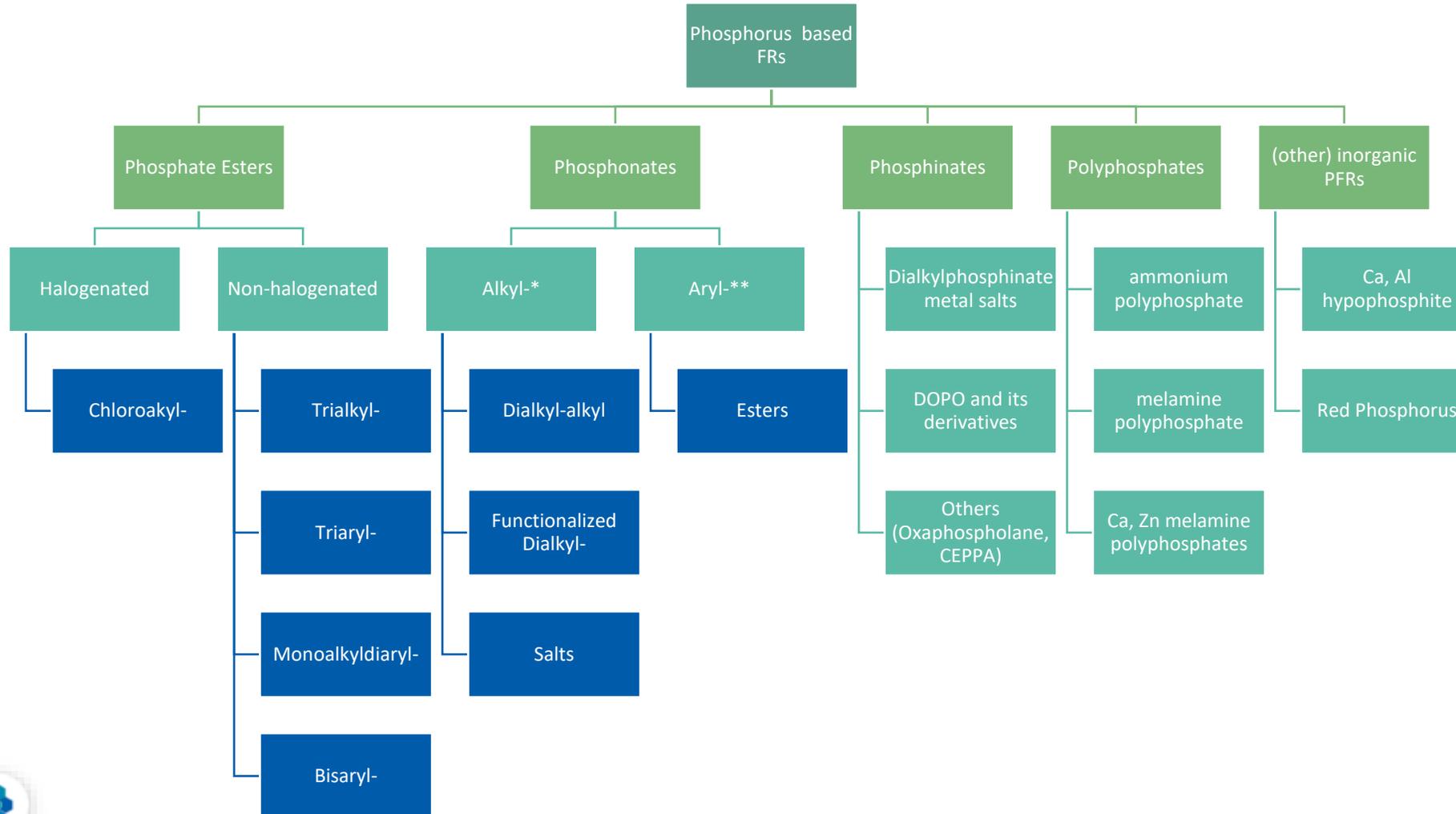
Regulatory strategy for flame retardants

March 2023

ECHA Strategy identifies several PIN flame retardants as low hazard, no regulatory action needed



The Grouping Approach: Example of Phosphorus-FRs



Phosphorus-based flame retardants (PFR) family tree based on chemical structure and commercial / technical relevance.

It should always be checked, whether a sub-division is necessary:
The different non-halogenated phosphate esters are an example of major differences in environmental behaviour and toxicology within a structural group.

*water soluble, **non water soluble (known commercial products)



ECHA Flame Retardants Strategy – Phosphorus FRs

Table 10: Summary of from the assessments of regulatory needs for organophosphorus flame retardants

Group/sub-group	No. FR	Immediate next action and hazard endpoints
Triphenylphosphate derivatives	18	CCH and SEV Repro. and ED
Trialkyl phosphates	10	CCH and potentially SEV for ED
Chlorinated trialkyl phosphates	11	Pending data for Carc.
Non-cyclic alkyl aryl esters of phosphoric acid	8	No action, Carc. 2 and unlikely hazard for mutagenicity and skin sensitisation
Alkyl (<C8) diesters of hydrogenphosphonates and alkyl(<C8)phosphonates	13	CLH proposal (IE) for CCH Repro., Muta. And neurotox
Alkyl esters of alkyl(C≥C8)phosphonates	5	CCH for PBT/vPvB
Other hydrogenphosphonates and alkyl phosphonates, their salts and esters	29	CCH unlikely hazard
Dibenzo oxaphosphorine oxide derivatives	11	Skin sensitisers No further action
Tetrakis(hydroxymethyl) phosphonium salts and their condensation products with amines	7	Skin sensitisers CCH Carc. Repro. STOT RE (liver) (1) Then CLH, Restriction entry 72 (REACH Annex XVII) and restriction proposal on skin sensitisers in textiles, leather, and fur and hide articles
Ethoxylated alcohol phosphates	1	CCH and potentially SEV for ED
Hydrocarbyl phosphinates	8	Generally of low hazard potential. CCH for Diethylphosphinates to clarify potential vPvM properties

“Thus, based on the current information, groups of low or unlikely hazards can be identified such as:

- Non-cyclic alkyl aryl esters of phosphoric acid,*
- Other hydrogenphosphonates and alkyl phosphonates, their salts and esters, and*
- Dibenzo oxaphosphorine oxide derivatives (DOPO derivatives)*
- Hydrocarbyl phosphinates”*

Inorganic phosphates, polyphosphates, phosphinates, phosphonates and phosphorus and its inorganic salts have been assessed with low hazard and no further EU regulatory risk management need.”

ECHA Flame Retardants Strategy 2023-03



ECHA raises environmental concerns over certain aromatic brominated flame retardants

ECHA/NR/24/40

The European Chemicals Agency's (ECHA) investigation found that use of non-polymeric aromatic brominated flame-retardant additives pollutes the environment due to their persistence, bioaccumulation and toxicity. These substances are released to the environment throughout the product lifecycle, with waste stage being of particular concern.

Helsinki, 18 December 2024 – ECHA has investigated, as requested by the European Commission, the uses and releases of aromatic brominated flame retardants (ABFRs), and their (potential) hazardous properties. It has also considered possible alternatives and aspects related to recycling and waste management.

European Commission has not yet issued a mandate for Restriction (2025-10)

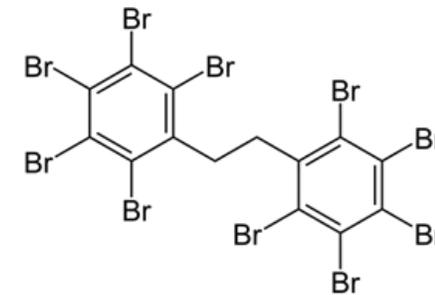
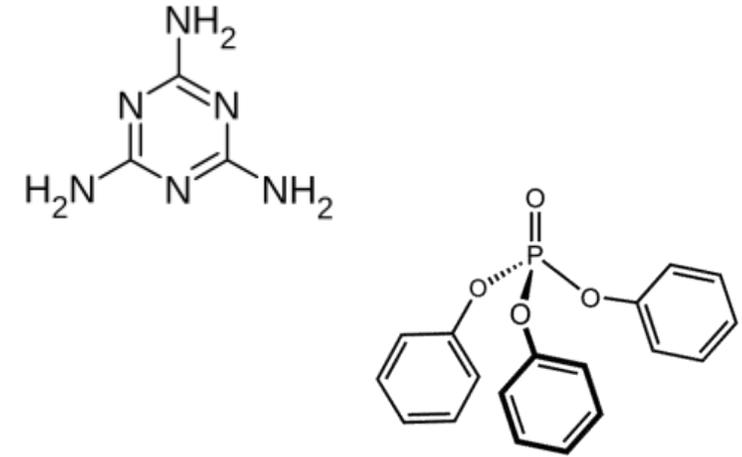
[ECHA news item Report](#) [PDF][EN]
[Appendix A-E](#) [PDF]
[Appendix F](#) [XLSX]
[Appendix G](#) [XLSX]
[Appendix H](#) [XLSX]

Substances of Very High Concern (SVHC)

- Melamine
- Triphenylphosphate (TPP)

Proposed:

- Decabromo diphenylethane (DBDEP)



- <https://chem.echa.europa.eu/obligation-lists/candidateList>

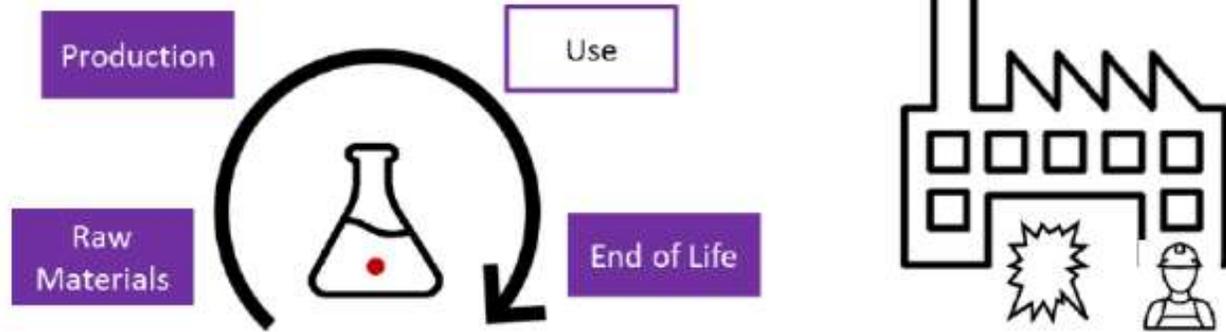
pinfa frequently asked questions (FAQ) about melamine-based flame retardants and recent regulatory risk management measures on melamine:

[pinfa-Melamine-based-FRs_QA.pdf](#)

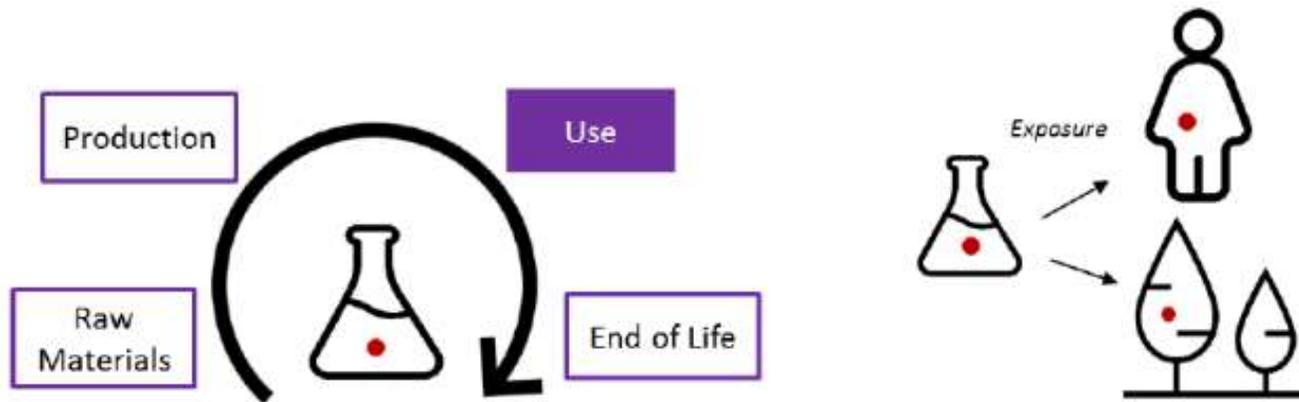
EFPA (European Melamine Producers Association) Regulatory Status information <https://melamine.cefic.org/regulatory-status/>



SSbD – criteria and procedure have been proposed by EU-JRC



(c) Hazards and risks related to the chemical/material final application



(d) Environmental impacts along the entire chemical/material life cycle



SAFE AND SUSTAINABLE- BY-DESIGN: A GUIDANCE TO UNLEASH THE TRANSFORMATIVE POWER OF INNOVATION

MARCH 2024



Cefic SSbD Guidance



What is a sustainable Flame Retardant?

Hazards

- PBT: Persistence, Bioaccumulation, Toxicity
- CMR: Carcinogenicity, Mutagenicity, Reproductive Toxicity
- Endocrine effects, Mobility (new)

Life Cycle

- Carbon footprint (global warming potential) and other Product Environmental Footprint criteria
- Production (value chain): impact on workers
- Use Phase: impact on consumers
- End-of-life → Recycling properties

Other

- Critical raw materials
- Fires: Smoke formation / toxicity
- Social impact



High uncertainty at the beginning of innovation

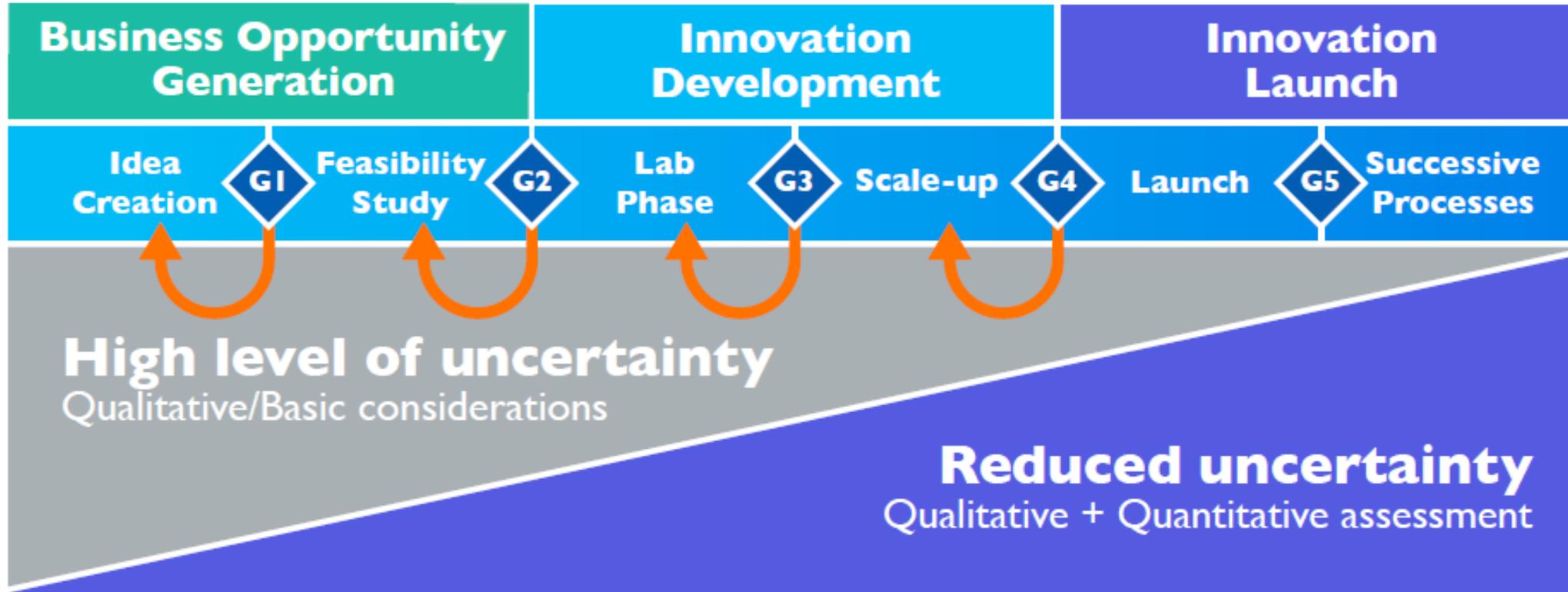
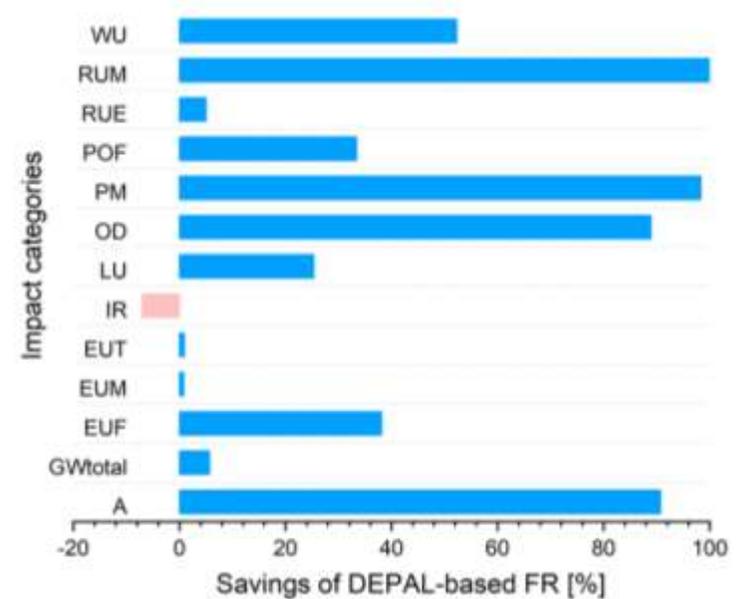
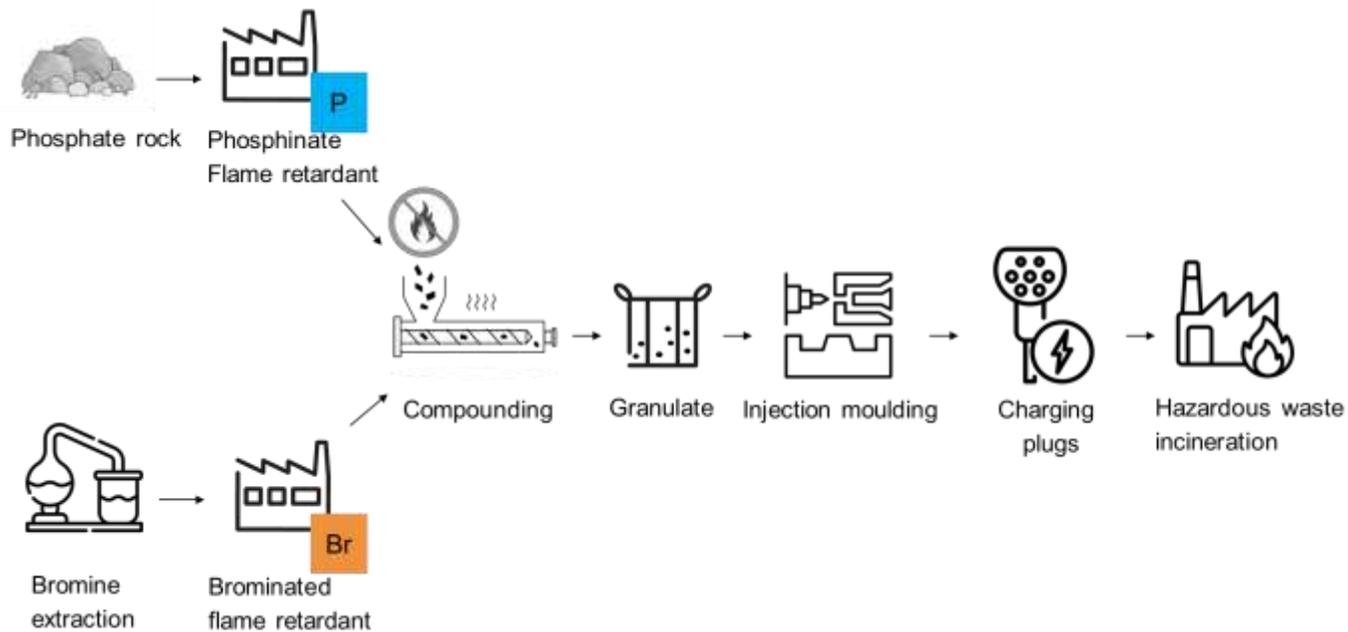


Figure 4. Simplified and idealised depiction of an iterative innovation process illustrating the increasing level of available detail for the safety and sustainability evaluation of new products



Life Cycle Assessment of Exolit OP 1400, published:

Phosphorus-based flame retardants for electrical parts
have life cycle benefits vs. bromine-based flame retardants



Challenges:
process / substance info from
suppliers, confidentiality, €€€

Toward Sustainable Fire Safety: Life Cycle Assessment of Phosphinate-Based and Brominated Flame Retardants in E-Mobility and Electronic Devices

Daniel Maga,* Venkat Aryan, and Adrian Beard



Cite This: <https://doi.org/10.1021/acssuschemeng.3c07096>



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Metrics & More



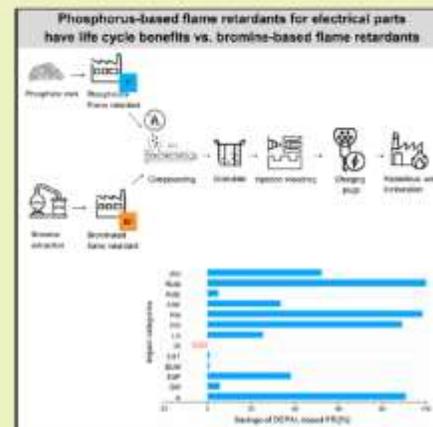
Article Recommendations



Supporting Information

ABSTRACT: The increasing market demand for electronic devices has raised concerns regarding the environmental impact of the flame retardants used in their production. Traditionally, brominated flame retardants have been used for their effectiveness despite their detrimental effects on the environment and hindrance to the principles of a circular economy. Evidently, harmful flame retardants should be replaced with less harmful ones. Hence, the exploration of alternatives, such as organophosphorus flame retardants like aluminum diethyl phosphinate (DEPAL), presents a promising avenue. Therefore, the goal of this study is to investigate the environmental impacts of DEPAL-based flame retardants in polyamides for use in connectors, plugs, and USB-C ports and to compare their impacts with those of their brominated flame-retardant counterparts. The life cycle impact results show that the flame-retardant polyamides using DEPAL have lower environmental impacts than the ones using halogenated flame retardants. Nonetheless, it is important to note that the production of phosphorus still requires large amounts of energy. Hence, switching to renewable energy can significantly lower the footprint of DEPAL. Furthermore, it offers an eco-friendly alternative to traditional flame retardants.

KEYWORDS: LCA, flame retardants, bromine, phosphorus, exolit, electronics, electric vehicles, SSbD (safe and sustainable-by-design)



LCA Example

– [Link to full text](#)

We need a toolbox, not a textbook ... PARC Project?



<https://www.parc-ssbd.eu/>

PARC = Partnership for the Assessment of Risks of Chemicals



PFAS and Flame Retardants

- ECHA to conclude scientific opinion on PFAS by end 2026
- “Background Document” version 14 issued
- PTFE is used as anti-drip in many FR formulations (→ UL 94 V0)
- proposed exemptions include:
 - Anti-drip agents in plastics – for electronic components only – 13.5 years.
 - Tolerances in plastics, textiles, papers and boards containing recovered materials,
 - Use in Personal Protective Equipment (PPE) - 13.5 years,
 - Thermal insulation foam blowing agents – 13.5 years,
 - Certain specific electrical, electronics and transport applications, inc. PCBs, wires and cables, certain vehicle and battery components ... – 6.5 or 13.5 years,
 - Certain technical textiles for vehicles – 6.5 or 13.5 years,
 - Polymer processing aids – 6.5 years,



Source: Microsoft Clipart



Increasing performance requirements for Flame Retardants

Property	Example
Flammability performance	UL 94 V0 + Glow wire ignition temperature 775 °C (GWIT)
Miniaturization – thinner cross sections	0.8 → 0.4 mm in UL 94 test sections
Mechanical properties	Elongation at break
Electrical properties, also after ageing	High dielectric strength & resistivity 150 °C / 1000 h
High Comparative Tracking Index (CTI)	> 600 V
Recycling	Using regrind up to 25%



CTI Test, photo: ©Clariant



Conclusion – Flame Retardants can be Sustainable

- Europe is pursuing ambitious chemical regulations
- SSbD concept
 - needs workable approach along innovation process
 - No one-size-fits-all - compromises will be needed
- pinfa:
 - input and support
 - build trust in FRs



Source: Shutterstock





www.pinfa.org



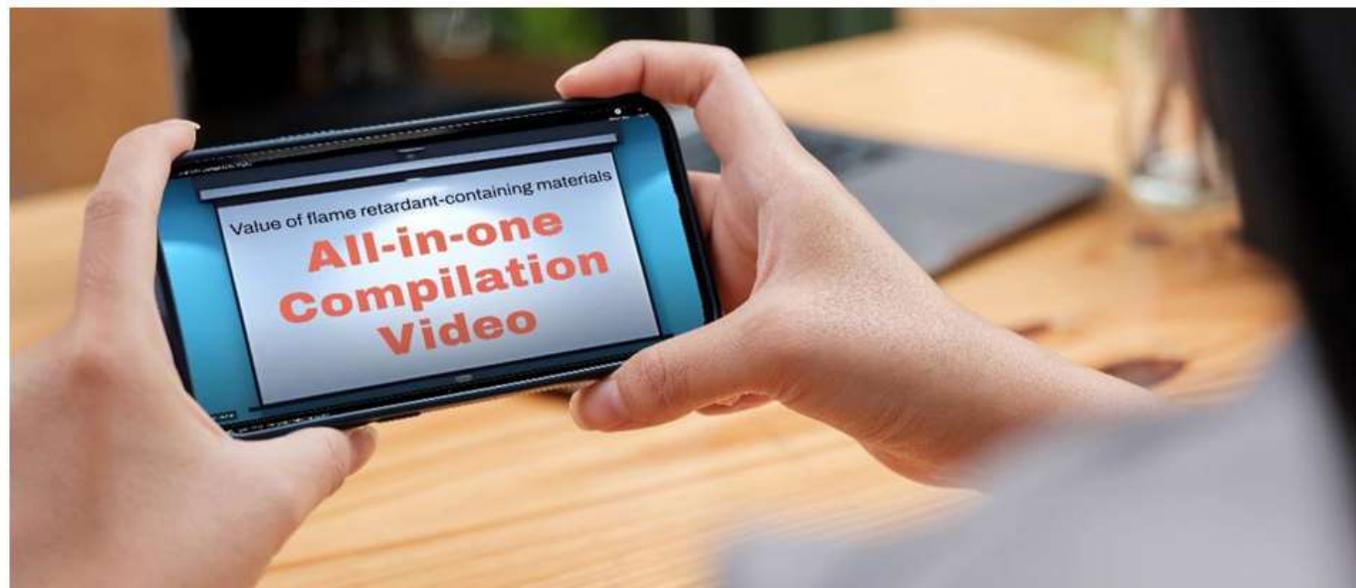
[www.linkedin.com/company/
pinfa-sector-group-of-cefic/](https://www.linkedin.com/company/pinfa-sector-group-of-cefic/)

Pinfa website and social media:

- Monthly newsletter sign-up
- Technical info on Flame Retardants
- Product Finder



Videos explaining Flame Retardants – Video #10 now released!



Our brand-new **All-in-One Compilation Video** brings together the best insights from our complete 10-part Learn Flame Retardants series into one concise, training-ready highlight reel, perfect for sharing with your team or refreshing your own knowledge.

[Watch Now](#)

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EDT (USA)

**“A Review of Antimony Trioxide Replacements
for Formulated FR Thermoplastic Polymers”**

Roger Avakian

(Avakian PolyChem Consulting, LLC)

pinfa animated logo



Thank you.

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About Cefic

Cefic, the European Chemical Industry Council, founded in 1972, is the voice of large, medium and small chemical companies across Europe, which provide 1.2 million jobs and account for 15% of world chemicals production. Cefic members form one of the most active networks of the business community, complemented by partnerships with industry associations representing various sectors in the value chain. A full list of our members is available on the Cefic website.

Cefic is an active member of the International Council of Chemical Associations (ICCA), which represents

chemical manufacturers and producers all over the world and seeks to strengthen existing cooperation with global organisations such as UNEP and the OECD to improve chemicals management worldwide

Cefic sector group 

The European Chemical Industry Council, AISBL – Rue Belliard, 40 - 1040 Brussels – Belgium
Transparency Register n°64879142323-90



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