

pinfa in Action

Free webinar: upgrading recycled plastics

pinfa at Electro-Plast 2026

pinfa sparks: recycling strategies for FRs

pinfa-NA new member: JLS Chemical

Policy and Regulation

REACH revision abandoned

Web campaign against Sweden ecotax

Court says US EPA must reassess DecaBDE

1	Recycling	5
1	PIN FRs compatible with PP recycling	5
1	Waste PET upcycled as phosphorus FR TPU	6
2	PIN flame retardant EPDM barriers	6
3	Non-halogenated synthetic textile fire safety	7
4	Non-halogenated FR ABS 3D-print filament	7
4	Supramolecular P-Co PIN FR for PC	7
4	PIN FR polycarbonate without PFAS	8
5	Publisher information	8

PINFA IN ACTION

pinfa-na

Phosphorus, Inorganic & Nitrogen Flame Retardants Association

Enhancing Recycled Plastics with Additive Solutions



Free webinar: upgrading recycled plastics

17th June. Madeline Daecher & Dean Dodaro, Polyvel, a leading compounder. How to restore properties of recycled polymers.

Plastics recycling is developing rapidly worldwide, driven by value-chain sustainability objectives, public policies and by virgin resource costs. But plastic recycle streams present challenges such as polymer degradation, odour, contaminants (including brominated flame retardants) ... Targeted additive packages can stabilise and compatibilise mixed feedstocks, restore polymers (chain extenders), enhance mechanical and aesthetic properties, control smell, and ensure fire safety, as well as being compatible with repeated recycling. Madeline Daecher and Dean Dodar are experts in technical product development and services, regulatory and sustainability at Polyvel, a US-based compounder specialised in additive masterbatches and custom formulations.

““Enhancing Recycled Plastics with Additive Solutions”, free pinfa-NA webinar: Wednesday 17th June 2026, 11:30 - 12:30 EDT (USA) = 17h30-18h30 CEST (Brussels time). This is pinfa-NA’s 23rd Lunch and Learn (L&L) webinar. Registration

https://us02web.zoom.us/webinar/register/WN_inDQcfCjQQ6nWqE_uLTiDq

Watch previous pinfa-NA L&L webinars: <https://www.pinfa-na.org/>



pinfa at Electro-Plast 2026

Fire safety was a central theme across multiple sessions and pinfa presented the wide range of PIN FR solutions available.

The 6th edition of Electro-Plast, Brussels, April 2026, brought together around 150 participants from across the electrical and electronic plastics value chain, including formulators, compounders, OEMs and technology providers. With a booth in the exhibition area, pinfa actively engaged with conference participants on fire safety challenges in electrical and electronic applications, particularly in the context of electrification, evolving regulatory requirements and sustainability objectives.



A strong impression from this year's Electro-Plast event was the high level of technical engagement. Exchanges underlined the need for continued dialogue across the value chain on how to maintain high levels of fire safety while materials and system requirements evolve. Discussions focused on the need for robust, reliable PIN flame retardant and smoke suppressant solutions. These must deliver proven fire performance whilst responding to pressure on material choices driven by regulatory developments, substance restrictions and customer expectations in demanding electrical, electronic and mobility applications. The conference highlighted how electrification and miniaturisation are raising fire safety requirements, notably through higher operating temperatures, compact designs and more complex electronic architectures. Participants repeatedly stressed that fire safety must remain a non-negotiable design criterion, alongside sustainability and performance considerations.

Electro-Plast 2026 confirmed the importance of early and open exchange between material suppliers, formulators and OEMs to ensure that future materials solutions remain both safe and fit for purpose, through a safe and sustainable by design (SSbD) approach. Proactive reformulation should anticipate regulations such as regulatory restrictions on brominated FRs, PFAS restrictions (PTFE - flaming-drip prevention) and the expected [EU End-of-Life Vehicle Regulation](#) recycling requirements (25% recycled content in plastics in new vehicles / 30% recycling from end-of-life vehicles).

Electro-Plast 2026, Polymers & Plastics in Electrical and Electronic Applications, 20-22 April Brussels <https://www.electro-plast.com/>

Next year's Electro-Plast is announced for 6-7 April 2027, Brussels.



pinfa sparks: recycling strategies for FRs

Over 60 participants at pinfa's 2nd 'sparks' webinar discussed recycling of PIN FRs with Nacho Montesinos Beltrán, AIMPLAS. Mr. Montesinos Beltrán, an expert in polymer recycling chemistry, underlined the difficulties of recycling post-consumer plastics which are an increasingly complex mixture of different polymers, additives and contaminants. Improving sorting is the first priority, but has limits because some items are multi-layered with different compounds which are bonded and cannot be separated.

Mechanical recycling (melt – reprocess) can be an option, but only if input materials are identical (closed-loop collection) or well sorted. Challenges are deterioration of polymers in ageing and reprocessing, mixing of polymers, dilution or breakdown of additives. Testing of some PIN flame retardants has shown compatibility with mechanical recycling, as they are designed to be resistant to ageing and processing conditions (see pinfa [Recycling Brochure](#)).

Other plastics recycling processes can address more complex mixtures of different polymers and additives.

Solvent recycling uses a cascade of different target solvents to progressively dissolve or depolymerise, then to separate, different polymers. Specifically adapted temperature and pressure conditions can improve separation. Organic PIN flame retardants can be separated and recovered by appropriately targeted solvent conditions.

Pyrolysis recycling can break down mixtures of different polymers to monomers and allow recovery of inorganic and some other PIN flame retardants.

Enzyme breakdown of plastics may in the future provide a low environmental impact route to recycling plastics and additives.

Halogenated flame retardants pose obstacles to recycling, by possible release of corrosive compounds during processing and because of the legal obligation to separate plastics containing brominated FRs under the WEEE Directive 2012/19.

In conclusion, the selection of the most appropriate recycling and flame-retardant removal/recovery strategy must begin with a detailed definition of the input waste stream, including the specific polymers, additives, contaminants, and flame retardants present. Only through a clear understanding of the composition of the incoming material can an appropriate recycling route be selected, enabling efficient flame retardant removal or recovery and ultimately ensuring a suitable upcycling approach for high-value plastic compounds

pinfa sparks 2nd webinar, Thursday 7 May 14h-14h45 (CEST), Closing the Loop: Recycling Strategies for Flame Retardant Additives, with Nacho Montesinos Beltrán, AIMPLAS. Watch online <https://www.pinfa.eu/resources/presentations/>

pinfa-NA new member: JLS Chemical

Chinese producer of PIN flame retardants, JLS Chemical, has joined pinfa NA, which now has 18 members. JLS Chemical was founded in 2001 in Hangzhou China and are a pioneer Chinese producer of non-halogenated flame retardants based on phosphorous and nitrogen. They have three facilities in Zhejiang, China, producing PIN FR powders (including APP, melamine cyanurate, melamine polyphosphate), and PIN FR masterbatches, including PIN FR polyols and fibre-grade chips. flame retardant polyols and chips for PP, PE, PVC, TPU, PET, polyamide 6 and 66. JLS Chemical has a worldwide network of agents and distributors. Typical product applications are intumescent coatings, textiles and technical textiles, engineering plastics, polyolefins, sealant and adhesive, wire and cable applications, fibres and coated leather. JLS Chemical are one of the 7 founding members of pinfa China.

<https://en.jlschemical.com/>

POLICY AND REGULATION



REACH revision abandoned

The European Commission has announced that the revision of the Chemicals Regulation is postponed indefinitely. In a published address, 27th April, to the European Parliament, the Commissioner for the Environment, Jessika Roswall, indicated that REACH would not be reopened, but that routes were being looked at to simplify and modernise the regulation by comitology (involving Member States but not the European Parliament). Discussion has been ongoing on REACH revision for several years, including a public consultation in early 2022 (see pinfa Newsletter n°133). The Commissioner noted the need to improve enforcement of existing REACH requirements for products imported into Europe.

This suggests that various proposals are for now abandoned or postponed, including REACH registration or notification of polymers, new hazard properties (such as endocrine disruption), generic risk assessment based on hazard properties without assessing exposure, Mixture Assessment Factors aiming to assess risk of a chemical when used alongside others.

Cefic published in February 2025 a 10-point “action plan to simplify REACH” emphasising the importance of assessing and regulating chemicals based on analysed risk not only on hazards, the need for dialogue with industry and stakeholders to identify priorities for regulation and underlining issues of enforcement.

“Commissioner Roswall’s address at a Structured Dialogue with Members of the European Parliament’s Committee for Environment, Climate and Food Safety (ENVI)”, Brussels, 27 April 2026

https://ec.europa.eu/commission/presscorner/detail/en/speech_26_897

Cefic policy REACH page: <https://cefic.org/policy/reach/>



Web campaign against Sweden ecotax

Sweden’s electric goods federations have launched a website pushing to abolish the national “ecotax” on electric goods, ahead of elections in Sweden in September. The website is launched by APPLIA (Home Appliances Sweden) and Elektronik Branschen (electronics federation). The Sweden electronics ecotax was introduced in 2017 with the stated intention of reducing use of certain chemicals, targeting in particular those containing bromine and also those containing phosphorus, but in fact all electrical goods are taxed according to weight. The website says that the tax costs consumers around 250 million €/year, collected by the Government, and has not changed chemicals usage. The tax is halved for electrical items which do not contain bromine or chlorine (halogenated FRs, PVC ...) and reduced to a low level (5% of base tax) if they do not contain phosphorus (phosphorus-containing PIN

FRs or plasticisers). The Sweden industry website says that flame retardants are important in electronics and that effective alternatives (to phosphorus FRs) are not available today.

Website in Swedish "Rebellion. Abolish the electronics tax now, Finance Minister" <https://elektronikskatt.se/>

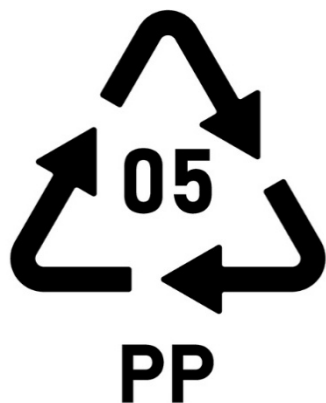


Court says US EPA must reassess DecaBDE

Federal Court of Appeal rejects US EPA decision to not take further action on brominated FR 'Deca'. The Environmental Protection Agency must now redo its safety analysis of the brominated flame retardant Decabromodiphenyl Ether (decaBDE). Deca was banned in the USA by EPA in 2021 (with some exceptions) and EPA concluded in 2024 that monitoring or further regulation of the substance were not necessary. This particularly concerned presence of the substance in recycled plastics, disposal of end-of-life materials, and presence in sewage sludge used on fields. The federal judges concluded that EPA's decision to take no further action was not supported by evidence.

"Ninth Circuit Burns EPA Over Flame Retardant Chemical Rule", 14th May 2026 <https://www.findlaw.com/legalblogs/ninth-circuit/ninth-circuit-burns-epa-over-flame-retardant-chemical-rule/>

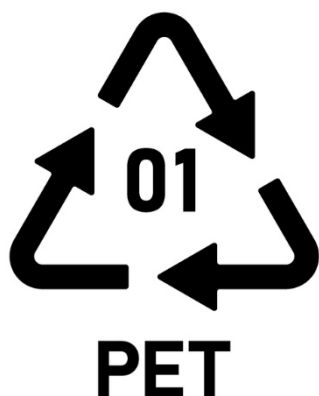
RECYCLING



PIN FRs compatible with PP recycling

Polypropylene (PP) with PIN FR was re-extruded five times, maintaining fire performance and mechanical properties. The PIN FRs tested were 2:1 (by mass) piperazine pyrophosphate and melamine pyrophosphate, with a total loading of 21% in the polypropylene. After melt compounding then five injection moulding cycles, the materials retained processability and thermal stability. Fire performance of UL 94 V-0 (3.2 mm) was maintained after the five reprocessing cycles, and peak heat release rate, limited oxygen index and smoke release were not significantly changed, remaining 4 – 6 x better than neat polypropylene. Tensile strength, flexural strength and impact strength were not modified by the reprocessing of the FR-PP, but elongation at break was deteriorated beyond 2 processing cycles.

"Recyclability of Flame-Retardant Polypropylene: Property and Flame Retardancy Assessment", G. Bernagozzi et al., *Polymers* 2026, 18, 845, <https://doi.org/10.3390/polym18070845>



Waste PET upcycled as phosphorus FR TPU

A PIN FR polyester diol, by phosphorus loading in solvent recycling of PET, was tested as PIN FR precursor in TPU (thermoplastic polyurethane). The phosphorus FR polyester diol was generated by dissolving / depolymerising waste PET (polyethylene terephthalate) in diethylene glycol, then reacting with adipic acid, then with CEPPA (2-carboxyethyl phenyl hypophosphite) and sodium acetate. This was then copolymerised with a glycol and MDI (methylene diphenyl diisocyanate) to generate a PIN FR TPU film (thermoplastic polyurethane). With a final phosphorus content of around 2%, LOI increased from around 27% (neat TPU) to 35% and achieved UL 94 V-0 (4 mm). The fire performance is suggested to be due to solid and gas phase actions of P and N in synergy. The PIN FR TPU also showed improved transparency and hydrolysis resistance compared to neat TPU. The authors suggest that this process reduces greenhouse emissions by more than one third compared to virgin TPU.

“Degradation-reconstruction-functional enhancement coupled upcycling of waste PET into recycled thermoplastic polyurethane with P-N synergistic flame retardancy”, Z. Jiang et al., Polymer Degradation and Stability 241 (2025) 111537 <https://doi.org/10.1016/j.polymdegradstab.2025.111537>

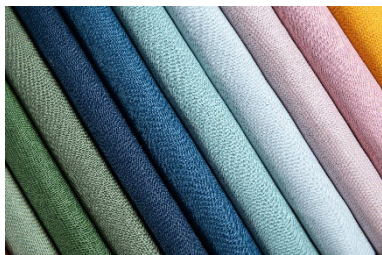
See also use of PIN FRs (ATH, zinc oxide) in solvent recycling of end-of-life PET to polyurethane foam in Vothi et al. 2024, in pinfa Newsletter n°166. Research and Innovation



PIN flame retardant EPDM barriers

The Rubber Company offers non-halogenated FR rubber for barriers in railway, marine, and industry, protective packaging. The black PIN FR EPDM (ethylene propylene diene monomer) sheeting is certified EN 45545-2 HL3 (European railway standard) for flooring and BS 476 part 7 Class 2 (surface flame spread). Because it is non-halogenated, it offers low smoke and low fire gas toxicity. It is resistant to weathering, ozone, dilute acids and bases and abrasion. Applications include railways, building, industry, marine, for both indoor and outdoor, as well as protective packaging, gaskets and seals.

“Flame Retardant EN 45545-2 EPDM Sheeting”
<https://therubbercompany.com/rubber-sheeting/epdm-rubber-sheeting/flame-retardant-en-455452-epdm-sheeting>



Non-halogenated synthetic textile fire safety

Textilcolor, with Alpex, Majocchi, and Trans-Textil roll out application of intumescent fire protection process. Textilcolor is a world leader in textile chemistry innovation. Textilcolor's patented technology provides permanent flame protection for polyamide and polyester fabrics by intumescence. Application maintains the breathability and stretch properties of fabrics. Alpex, France, Majocchi, Italy (both part of the AIMa Group), and Trans-Textil, Germany, will roll out application for high-end textiles for military, personal protective equipment and luxury / fashion, including in Öko-Tex labelled applications.

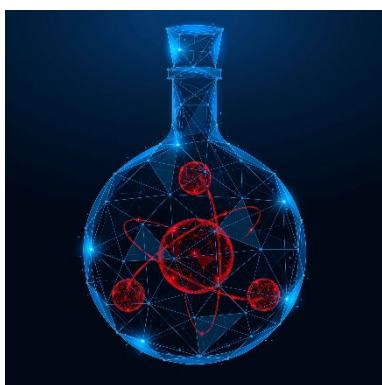
"Textilcolor AG launches strategic collaboration with Alpex, Majocchi, and Trans-Textil in the field of Pyroshell™ flame protection", 1 November 2025
<https://www.textilcolor.ch/en/company/news/357-press-release>



Non-halogenated FR ABS 3D-print filament

Formfutura, a global leader in additive manufacturing materials, offers high-speed PIN FR ABS filament. The black ABS 3D-print filament includes polycarbonate and non-halogenated flame retardants, enabling to achieve UL 94 V-0 and self-extinguishing printed objects. It is suitable for traditional and high-speed 3D print technologies, and offers dimensional stability, high interlayer adhesion, layer height down to 0.1 mm, and print temperatures 240 – 265 °C. It is available in 1.75mm or 2.85mm diameters.

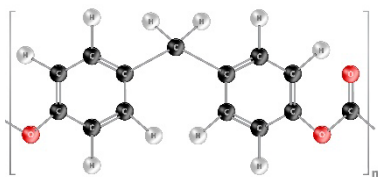
"ABSpro Flame Retardant", Formfutura
<https://www.formfutura.com/shop/abspro-flame-retardant-81>



Supramolecular P-Co PIN FR for PC

PIN FR achieves UL 94 V-0 in polycarbonate at 2.5% loading, reduces fire gases, improves mechanical properties. The supramolecular phosphorus-cobalt PIN FR was synthesised by reacting diphenylphosphinic acid (DPPA) with cobalt acetylacetonate. UL 94 V-0 was achieved at 1.5% loading in polycarbonate (thickness not specified, neat PC = V2). At 2.5% PIN FR loading, LOI was improved from 24.5% for neat PC to 33% and peak smoke and carbon monoxide release were reduced by 50-60%. The authors attribute the fire performance to efficient, catalytic char formation and the smoke and toxic gas reduction particularly to the redox effects of cobalt derivatives. The supramolecular P-Co PIN FR shows improvement of processing thermostability, improved impact strength and maintains tensile strength compared to neat PC. A table compares these results to literature data for around twenty other P-based FRs in PC.

"Supramolecular flame retardants towards fire safe polycarbonate with high thermal stability and smoke-suppression properties", L. Liu et al., Journal of Materials Science & Technology 242 (2026) 173–185
<https://doi.org/10.1016/j.jmst.2025.04.016>



PIN FR polycarbonate without PFAS

Science review summarises PIN FR solutions for transparent polycarbonate (PC) without PFAS anti-drip agents. Neat polycarbonate is flammable with UL-94 rating of V2 and emission of dense toxic smoke. A range of PFAS substances are used as FR synergists and anti-drip agents in PC, including polytetrafluoroethylene (PTFE), perfluorooctanoic acid (PFOA) and salts, potassium perfluorobutane sulfonate (PFBS/K+, Rimar salt) and perfluorooctane sulfonate (PFOS). Different PIN FR solutions are presented which can achieve UL 94 V-0 in PC without PFAS additives: P-N systems (including phosphate esters, phosphaphenanthrenes, phosphazenes, and phosphines combined with amides, amines, imidazoles, and pyrazines), siloxanes, sulfonates, nano-based. The paper emphasises sulfonates, because they degrade to release SO₂ at the degradation temperature of polycarbonate, resulting in reactions which enhance char formation. They can also act in the gas phase when combined with metal ions. However, they cannot alone achieve UL 94 V-0 in low thicknesses because of flaming dripping.

“Recent Advances and Perspectives in UL 94-0 Rated Flame - Retardant Polycarbonate: Addressing Challenges Under Per - and Polyfluoroalkyl Substances Bans”, T. Sai et al., Safety Science and Technology, 2026; 1:e70001, <https://doi.org/10.1002/sst3.70001>

PUBLISHER INFORMATION

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