pinfa
Phosphorus, Inorganic & Nitrogen Flame Retardants Association

Your newsletter for non-halogen fire safety solutions n° 119 December 2020

EUROPEAN FIRE SAFETY WEEK

EUROPEAN FIRE SAFETY WEEK 2020

Webinar: Fire safety and electric vehicles

Organised by pinfa in the European Fire Safety Week, the webinar 19th November 10h-11h30 CET will discuss: the specific new fire risks of electric and hybrid vehicles, approaches developed by the car industry and suppliers to address these risks and policy actions and research needs. Speakers will include EU policy makers, automotive industry, fire fighters and researchers/testing companies with experience of e-vehicle and battery fires.

European Fire Safety Week, organised by European Fire Safety Alliance https://www.europeanfiresafetyalliance.org/upcoming-events/ *(all times CET)*

Tue. 17th November, 10h-11h30: Fire safety and vulnerable people

Tue. 17th November, 14h-15h30: Fire safety awareness

Wed. 18th November, 10h-11h30: Smoke in residential buildings

Thur. 19th November, 10h-11h30: Fire safety in transport energy transition *– co-organised with pinfa – direct link* https://www.europeanfiresafetyalliance.org/european-fire-safety-week-2020/webinar-4/

Thur. 19th November, 14h-15h30: Fire safety competency in energy transition for buildings.

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POLICY, CALLS AND CONSULTATIONS

EU Chemicals Strategy published

pinfa supports the European Commission': "*safer and more sustainable chemicals are a great economic opportunity*". Part of the Green Deal, the new EU "Chemicals strategy towards a toxic-free environment" defines a number of orientations and changes in EU chemicals policy which will be taken forward in coming months and years.

Flame retardants are mentioned only once in background information "… *hazardous chemicals in human blood and body tissue, including … … … and flame retardants*".

Under innovation, opportunities for chemicals in certain sectors is noted: "*construction materials, textiles, low-carbon mobility, batteries, wind turbines and renewable energy sources*". pinfa notes that flame retardants play a valuable role in all of these sectors where fire safety is important.

Several of the actions announced are of specific relevance to pinfa:

- **"*develop EU safe and sustainable-by-design criteria for chemicals*"** including introducing into REACH information requirements on "*overall environmental footprint*" of chemicals.;
- emphasis on **recycling**, including "*investments in innovative technologies to address the presence of legacy substances in waste streams*";
- "*promote the EU's resilience of supply and sustainability of chemicals used in essential applications for society through **EU funding and investment mechanisms***"
- defining a "***research and innovation agenda** for chemicals*"
- defining **criteria for "*essential uses*" of chemicals**.

Some FRs will be concerned by actions applicable to all chemical classes, such as

- Introducing into REACH chemical safety assessments a "*mixture assessment factor*" and other actions on **combination effects** of chemicals
- **new hazard classes** and CLP Regulation criteria for environmental toxicity, persistency, mobility, bioaccumulation, endocrine disruptors; banning of endocrine disruptors in consumer products as soon as they are identified (except provenly essential uses);
- review of the **definition of nanomaterials;**
- **extension of REACH registration to "*certain*" polymers;**
- **emphasis on compliance**, e.g. for REACH dossiers, and on **information on chemicals in products**, e.g. by "*introducing*

information requirements in the context of the Sustainable Product Policy Initiative".

In a separate document, the European Commission reviews art. 33 of REACH: **supply chain information on SVHCs** (substances of very high concern) in articles. The conclusion is that this article is not effectively implemented: retailers do not have adequate information, and are unable to respond to consumers' '*right to know*'. The situation is even worse for articles placed on the market by e-commerce where there is a "*general lack of information on the presence of SVHCs*"

Summary: European Commission press release IP/20-1839, 14th October 2020 "Green Deal: Commission adopts new Chemicals Strategy towards a toxic-free environment"
https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1839

COM(2020)667 "Chemicals Strategy for Sustainability Towards a Toxic-Free Environment", 14th October 2020
https://ec.europa.eu/environment/pdf/chemicals/2020/10/Strategy.pdf

SWD(2020)247 review of Implementation of art. 33 of REACH (supply chain information on SVHCs in articles) "Review of certain provisions of Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restrictions of Chemicals (REACH), as laid down in its Article 138", 14th October 2020
https://ec.europa.eu/environment/pdf/chemicals/2020/10/SWD_article_138.pdf

EU consultations

Construction Products Regulation: open to 22nd Dec. 2020.

See pinfa Newsletter n°117. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12458-Review-of-the-Construction-Products-Regulation/public-consultation

Product sustainability claims, substantiating environmental performance and PEF (product environmental footprinting):

open to 3rd Dec. 2020

See pinfa Newsletter n°117 https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12511-Environmental-claims-based-on-environmental-footprint-methods/public-consultation

EU R&D funding on wildfires

Call for projects on preventing and fighting wildfires (Horizon 2020) open to 26 January 2021 @17h. The call states objectives of reducing accidental wildfire ignitions by 50% and wildfire smoke emissions by 55% by 2030. R&D projects should address predicting, preventing and fighting wildfires, mitigating their impacts and restoration - adaptation, and governance around prevention, awareness, preparedness.

Horizon 2020 call "Preventing and fighting extreme wildfires with the integration and demonstration of innovative means", LC-GD-1-1-2020
https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/lc-gd-1-1-2020

SCIP database for SVHCs in articles

New EU online database opens for companies to declare SVHCs (substances of very high concern) in articles. ECHA (the European Chemical Agency) has opened the SCIP database (Chemicals of Concern in Products). This enables companies to declare the presence in their products (> 0.1% w/w in "articles" or in complex products) of chemicals on the REACH Candidate List of SVHCs, as obliged by the Waste Framework Directive, by the deadline of 5th January 2021. The objective is to provide information to consumers, to workers and to recycling companies, so making recycling safer.

Flame retardants which are on the SVHC candidate list are: Boric acid, Disodium tetraborate, DecaBDE, Hexabromocyclododecane (HBCDD), Dechlorane Plus, Short Chain Chlorinated Paraffins, Tris(2-chloroethyl) phosphate, Trixylyl phosphate.

"Tracking chemicals of concern in products – SCIP database ready for use" ECHA/PR/20/07, 28th October 2020 https://echa.europa.eu/fr/-/tracking-chemicals-of-concern-in-products-scip-database-ready-for-use

ECHA SCIP Database https://echa.europa.eu/scip-database

See also pinfa Newsletter n°106.

REACH Candidate List: https://echa.europa.eu/web/guest/candidate-list-table

Canada assesses melamine, TCPP, TDCPP

The Canadian Government has published draft screening assessments of melamine and of the chlorinated FRs TCPP and TDCPP.
These are **open to consultation input to 16th December 2020**. For TCPPP & TDCPP, it is proposed to conclude that they meet Canada section 64 criteria (harmful to the environment or to human health, as currently used), that they are persistent but not bioaccumulative, and that they do not pose a risk in the environment.

For melamine, it is also proposed to conclude that it meets Canada section 64 criteria, because of inadequate data on exposure from skin contact with furniture and mattresses.

Both risk management documents request stakeholder information on alternatives to the use of flame retardants in upholstered furniture and mattresses.

Melamine: draft evaluation, risk management scope

TCPP & TDCPP: draft evaluation, risk management scope

PIN FLAME RETARDANT INNOVATION

PIN FR fibres for rail standard composites

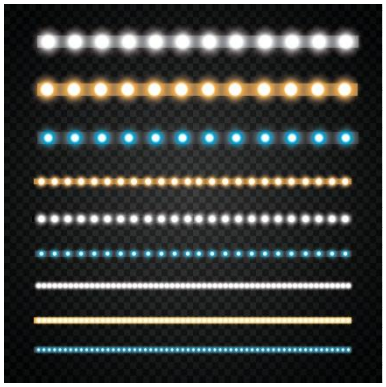
Integrating TFP's nonwoven PIN FR fibre mat into epoxy, carbon-fibre epoxy and polyester enables a pass in key elements of EN45545-2. TFP (Technical Fibre Products) is a UK-based manufacturer of nonwovens, part of the James Cropper Group. The PIN FR mat is based on inorganic fibre and expandable graphite. Incorporated into polymers in composite production it provides fire safety by intumescence, expanding unidirectionally in fire. At the University of Nottingham Ningbo China, rail interior panel parts were produced using three different materials: non-FST (non-fire, smoke & toxic fume rated) epoxy, the same epoxy with carbon fibres, and vacuum-cured polyester, in all three cases with and without (control) the PIN FR fibre mat (20 mm). The controls all achieved only EN45545-2's lowest rating: HL1 (R1). With the PIN FR mat, all three panels achieved HL2 (R1) for MARHE, $D_S(4)$ and VOF4 and the even higher HL3 rating for $CIT_{8\ mins}$. The HL2 (R1) fire rating means the composite parts can be used in most interior applications in railway and underground trains. Full scale wall-window panels with the PIN FR mat showed mechanical properties surpassing specifications for underground trains.

See also Tecnofire in composite poles for energy and telecommunications cables in pinfa Newsletter n° 114. "Tecnofire® Success in Fire Testing for Rail Applications", October 2020 https://www.tfpglobal.com/news-and-media/news/tecnofire-success-in-fire-testing-for-rail-applications

High-performance, ultra-insulating polymers

pinfa member BASF has developed new bromine, chlorine and antimony free FR polyamide and polyester solutions for IT, construction, e-mobility. The new compounds are an unreinforced polyester, and a reinforced polyamide. They offer fire performance (UL94-V0 @ 0.4 mm), highest CTI electrical insulation rating (600 V) and are compatible with injection moulding of complex and thin-wall parts, for e.g. miniaturised electronics, and e-vehicle applications such as high-voltage plugs, charging infrastructure, battery modules and housings. They can be produced in bright colours, including e-mobility orange. The polyester is also suitable for the extrusion of e.g. filaments or pipes.

"New plastics set standards in flame retardancy and electrical insulation", BASF 28th September 2020 https://www.basf.com/global/en/media/news-releases/2020/09/p-20-307.html



Thermally conductive epoxy resins for LEDs

Electrolube has developed thermally conductive PIN flame retardant epoxy resins for LEDs. ER2074 is a white resin which uses PIN flame retardants to achieve UL94-V0 with low smoke and fumes. It is thermally conductive (1.26 W/m.k), does not contain abrasive fillers so is processing friendly, and offers high water and chemical resistance. Its white colour after curing offers appearance advantages and combined with its thermal conductivity makes it ideal for applications in LED lighting, both internal and external. Electrolube has also announced a first transparent UL94V-0 resin, UR5641, again using PIN flame retardants, and using aliphatic urethane chemistry resistant to yellowing. It offers thermal conductivity of 0.35 W/m.K and operating temperatures -40 to 120°C. Electrolube is a global formulated chemical supplier since 1941 to electronics and industry.

"Electrolube Launches First Clear UL94 V-0 Flame Retardant PU Resin for any LED Market" 23 October 2019
https://electronicsmags.com/electrolube-launches-first-clear-ul94-v-0-flame-retardant-pu-resin-for-any-led-market/

and https://www.electrolube.info/pdf/tds/044/UR5641.pdf

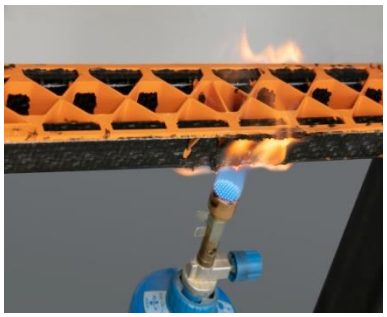
and https://electrolube.com/product/er2074-thermally-conductive-white-epoxy-resin/

HFFR compounds for e-vehicle cables

Padanaplast launches PIN flame retardant compound for ultra-flexible, high-voltage e-vehicle battery and powertrain cables. The new performance XLPO-HFFR (halogen-free flame retardant, silane cross-linkable polyolefin) compound also offers thermal and mechanical performance necessary for automotive applications and resistance to oils and fuels. It is part of Padanaplast's series which also includes T3 (125°C) optimised XLPO-HFFR wire and cable insulation compounds and elastomer grades adapted for e-vehicle charging. The non-halogenated flame retardant systems used, with silane cross-linking, provide weathering resistance and ensure self-extinguishing, no halogenhydric acid* release and low smoke, low toxicity, low corrosivity. They are fast curing and offer high extrusion speed in standard extruder lines. The absence of acid-releasing halogens facilitates end-of-life recycling.

** halogenhydric acid = HX where X is a halogen, e.g. HCl or HBr.*

"Padanaplast offers new advanced HFFR compounds for high - performance wires and cables for electric vehicles", 22nd October 2020
http://www.padanaplast.com/pp/news



Tough new PIN FR polyamides

pinfa member, Lanxess, has developed high strength & rigidity PA6-fibre composites achieving UL94-V0 @ 0,5 mm. The materials have high glass- or carbon-fibre content to ensure mechanical strength, rigidity and energy absorption, and use PIN flame retardants to achieve high fire performance, including a composite for railway applications (EN 45545-2). The PIN FR package is designed to not affect mechanical performance. Applications include electrical and electronics, in particular where mechanical resistance is required such as components for electric vehicles, electronic housings, railway and industrial applications.

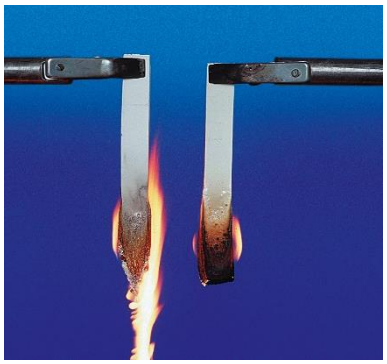
Photo: Lanxess' in-house fire test: the black carrier profile is made of one of the new Tepex grades, the rib structure of an orange polyamide 6 Durethan (also halogen-free FR). The flames do not spread, but extinguish when the burner is removed, regardless of whether the carrier is flamed over the surface or at the edges.

"Tough and very fire resistant", Lanxess, 16th October 2020
https://lanxess.com/en/Media/Press-Releases/2020/10/Tough-and-very-fire-resistant See also Lanxess compounds for e-vehicles in pinfa Newsletter n° 114

Mineral based FR synergist for CPR cables

Nabaltec's new synergist improves processability, ageing and fire performance of ATH-filled LFHFR cables. Low Fire Hazard Fire Resistant cables achieve CPR (EU Construction Products Regulation) criteria for reaction of cables to fire, smoke production, thermal decomposition acidity and flaming droplets. In PE/EVA (polyethylene/ethyl vinyl acetate) this requires 55 – 70 % loading of metal hydrate PIN FRs (ATH aluminium trihydrate or MDH magnesium di hydroxide), but this can impair the cable's mechanical properties, ageing or processing. pinfa member Nabaltec's new synergist masterbatch, at 3 – 4% loading, has been shown to reduce total loading necessary (e.g. from 70% ATH only to 65% ATH+synergist in LLDPE/EVA to achieve UL94-V0 @ 1.6 mm), improve processability (twin-screw extruder or internal kneader), reduce mechanical deterioration under hot air ageing.

"ACTILOX® PA-B2. Processing Aid and Flame Retardancy Booster. A novel mineral based flame retardant synergist for Wire & Cable", C. Neumeister et al., Nabaltec, 10/2020
https://nabaltec.de/presse/mediathek/#white-papers



Synergist to improve PIN FR thermoplastics

BYK has launched a non-halogenated synergist which improves fire performance, processing and material properties, and reduces weight, of PIN FR thermoplastics. The synergist is a specific organophilic sheet silicate. Applications include engineering plastics such as polyamides. At a loading of 5%, the synergist reduces or prevents burning droplets and improves char formation, so improving fire performance. It can improve barriers to oxygen, water vapour and hydrocarbons, enable optimisation of PIN FR and filler loadings, and improve melt viscosity, so improving dimensional stability during profile extrusion. Applications include EVA (ethylene vinyl acetate), LDPE (polyethylene), polypropylene, polylactide and polyamides.

"Flame retardant synergist BYK-MAX CT 4260 is a K 2019 Show highlight", 1 August 2019 https://www.byk.com/jp/press-events/detail.html?newsID=5869

Dietzel Univolt PIN FR "HFT" cable conduits

Innovating in cable conduits since 1938, the Austrian company Dietzel Univolt considers its range of "HFT Next generation" LSF0H (Low Smoke and Flame, Zero Halogen) conduits as a frontrunner in sustainability. Using PIN flame retardants, the conduits are HFT (halogen-free, flame retardant, temperature resistant) and fully recyclable. The conduits are also resistant to impact and compression, UV radiation and out-door weathering, chemicals and lubricants and are suitable for use in concrete and flexible in cold condition. They can thus substitute for PVC and steel cable management systems, offering easier installation. The commitment to sustainability is integral to Dietzel Univolt, committed to reducing and recycling waste, reducing carbon impact and water use and ensuring product sustainability. The company is part of the UN Global Compact initiative of sustainable companies and stakeholders.

Dietzel Univolt HFT Next Generation https://www.dietzel-univolt.com/news/hft_lsf0h - "A lesson in sustainability learned" https://www.electricaltimes.co.uk/a-lesson-in-sustainability-learned/ 8th November 2019. See also: pinfa Newsletter n°32.

PIN FR innovation for lithium ion batteries

Scientists have developed low weight, high-safety components to improve lithium ion batteries, using phosphorus PIN FRs. A publication from Stanford University and SLAC (US National Accelerator Laboratory) proposes to replace the meal foils currently used as current collectors in lithium ion batteries by a sandwich of ultrathin copper (c. 500 nm) and polyimide with 25% TPP (tri phenyl phosphate) PIN flame retardant (9 000 nm). Current collectors today represent 15 – 20 % weight of lithium ion batteries, and though essential are inactive, not contributing to cell capacity. Compared to the thinnest current copper foils, the proposed sandwich collectors enable a 16 – 26% improvement in battery specific energy. The TPP included in the sandwich current collectors is sufficient to considerably improve fire safety of lithium ion cells: a traditional cell burns vigorously and is completely destroyed within 20 seconds of exposure to an open flame, whereas the TPP-sandwich containing cell self-extinguishes within around 6 seconds.

"A new approach boosts lithium-ion battery efficiency and puts out fires, too" https://scienceblog.com/519032/a-new-approach-boosts-lithium-ion-battery-efficiency-and-puts-out-fires-too/ and full article "Ultralight and fire-extinguishing current collectors for high-energy and high-safety lithium-ion batteries", Y. Ye et al., Nature Energy, vol. 5 Oct. 2020, pp. 786-793 https://doi.org/10.1038/s41560-020-00702-8

chemsec MARKETPLACE

PIN FRs strong in alternatives 'Marketplace'

Nearly forty companies are now offering PIN FRs on ChemSec's Marketplace for safer alternatives. The environmental NGO ChemSec's Marketplace which enables companies to advertise chemicals with positive environment and health profiles, which aim to substitute problematic chemicals (in particular those on the SIN and Substitute Now lists). The Marketplace now has over 560 offers, of which nearly forty are for PIN flame retardants or formulations containing PIN FRs, including from a number of pinfa members.

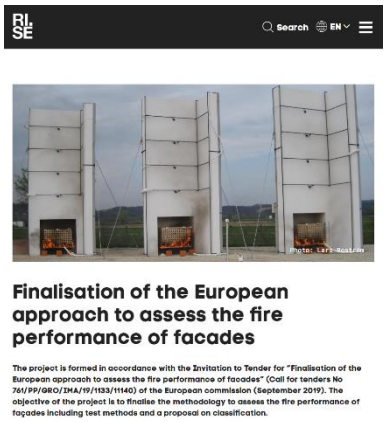
"The number of Marketplace ads just went from 253 to 565!", ChemSec, 8th October 2020 https://marketplace.chemsec.org/articles/news/2020/10/08/the-number-of-marketplace-ads-just-went-from-253-to-565/ and search for flame retardants here https://marketplace.chemsec.org/

TESTING AND STANDARDS

International fire safety standard published

60-page first edition of IFSS "International Fire Safety Standards: Common Principles" was released 1st October 2020. IFSS is a global coalition of 80 organisations professional institutes and fire safety leadership organisations, including the UN. Its aim is to address differing, or non-existent, requirements to fire safety in countries across the world. The new "Common Principles" covers legislation, codes or regulations and standards in all stages of a building's life cycle, addressing fire prevention, detection & communication, occupant protection, containment and extinguishment. The principles require building design to consider product safety, electrical safety, combustibility and smoke-producing characteristics of materials and systems, including interior and exterior materials and room contents.

IFSS Coalition https://ifss-coalition.org/ and "International Fire Safety Standards: Common Principles. Safe Buildings Save Lives", IFSS, 5th October 2020 http://www.fpaa.com.au/media/295676/ifss-cp_1st_edition_5th_oct_2020.pdf



New test method for facades underway

Lars Boström, RiSE, at an online webinar, presented progress to finalise the new EU building façade fire test. Building facades with insulation material will make a major contribution to energy savings, with major investments planned with the EU Green Deal "Renovation Wave". The fire test project was launched in February 2020 (see pinfa Newsletter n°115) and follows the report for the EU in 2018 (pinfa Newsletter n°95) recommending an approach based on the BS8414 and DIN 4102-20 large-scale façade tests, but taking the "alternative method" option with a secondary opening (simulating a window in a façade) and other improvements. The aim is to develop a Harmonised EU test, replacing the dozen different tests currently used in Europe. Current work aims to ensure repeatability, with round-robin tests between different laboratories, and to integrate an option to evaluate the floor-wall junction, and to ensure dialogue with regulators and industry towards acceptance of the new test method. Webinar discussion underlined that façade testing must be part of an overall building safety approach, including flexibility to assess new materials and façade systems (small scale testing plus fire engineering and modelling), training of architects and engineers to ensure appropriate implementation and verification and control of installation and maintenance.

Webinar with Lars Boström 13th October 2020
https://firesafeeurope.eu/webinar-assessment-of-the-fire-performance-of-facades-in-the-future/

Fire safety in building sustainability labels

A webinar discussed the feasibility of a fire safety rating scheme for buildings based on a safety assessment model. The event was organised by the "European Fire Safety Community", which is an initiative of "Fire Safe Europe" (FSEU). Nearly 140 participants were online. FSEU explained that their objective is to develop a fire safety rating scheme for buildings, performance based, to provide a consumer "label", and based on data and modelling of fire safety assessment.

Daniel Joyeux, Efectis, noted the need for more data to support fire risk assessment models, in combination with fire testing, in particular on product fire performance after ageing.

The importance of building contents contribution to fire risk was raised. Daniel Joyeux indicated that flame retardants in upholstered furniture have a strong influence on overall building fire performance, especially in homes.

Bando Benifei, Member of the European Parliament, underlined the importance of data and of balancing fire safety with chemicals use. Zeljana Zovko, Member of the European Parliament, pointed to the motion proposed by 20 MEPs proposing the creation of a European Fire Safety Day on 31st May (date of the Great Fire of Zagreb, 1731). She underlined the impacts of fire, both on people and on cultural heritage (example of the Notre Dame fire, Paris, 2019) and the need for Member States to work together on fire safety.

A session discussed fire safety in building sustainability rating schemes. Schemes such as RELi, BREEAM, LEED, DGNB and the EU reporting framework for sustainable buildings Level(s) tend to not include fire safety because it is considered to be covered by regulation. Dorin Bleu, Romania Green Buildings Council and John Fingleton, Irish Green Building Council and Cristian Maluk, University of Queensland indicated that fire safety is seen as too complex, especially with the importance of maintenance and training. They noted however that sustainability of buildings does increase fire risk (e.g. with the move to denser homes, increasing use of insulation materials) and that there is inadequate data on the environmental impacts of accidental fires.

Webinar link: https://eufiresafety.community/page/eufscsummit2020

Fire testing roof photovoltaics

Roof PV installations show variable fire performance depending on PV unit and roof materials and on installation. The Italian Ministry of the Interior, National Fire and Rescue Service (CNVVF) has published specifications for testing photovoltaic modules mounted on roof systems. This paper presents a summary of relevant national, EU and international fire testing standards, and result of fire testing of roof - PV unit systems using different fire test configurations, including classification results under the Italian

national system and proposed EU CPR ratings. Photos show PV panels engulfed in flames during testing. The authors note that the PV back sheet (mainly polyester and/or PVF) showed good reaction to fire whereas EVA ensuring assemblage of the backsheet to the PV module tended to be rapidly combustible.

"PV modules on buildings – Outlines of PV roof samples fire rating assessment", P. Cancelliere et al., Fire Safety Journal 2020
https://doi.org/10.1016/j.firesaf.2020.103139

RESEARCH AND DEVELOPMENT

PIN FRs reduce smoke emission from wood

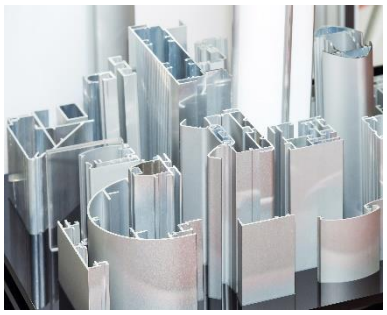
Tests show that APP protects wood composites from fire and reduces smoke and zeolites enable further improvement. A synthetic aluminium silicate zeolite (hierarchically porous H4A) was loaded with ammonium polyphosphate, by in situ reaction of phosphoric acid and urea. 10% of either APP or APP-zeolite were tested included into wood resin of poplar sawdust pressed in phenol formaldehyde resin. Both APP and APP-zeolite reduced the peak heat release rate (cone calorimeter) by nearly 50% and delayed it from around 6 to 8 minutes. APP alone reduced the peak smoke production rate by around one third, and APP-zeolite reduced it by around half. Both also reduced carbon monoxide release.

"Reducing the fire toxicity of wood composites using hierarchically porous 4A (H4A) zeolite modified ammonium polyphosphate (APP) synthesized by a facile in-situ method", Z. Zhang et al., Construction and Building Materials 262 (2020) 120754
https://doi.org/10.1016/j.conbuildmat.2020.120754

Researching bio-based phosphorus PIN FR

Ground banana peel combined with phytic acid improves fire performance of poly lactic acid. The banana peel powder was reacted with 3-aminopropyltriethoxysilane, then with phytic acid (a bio-sourced molecule rich in phosphorus) and ammonia. 15% loading of the resulting PA-B (phytic acid – banana) in PLA (poly lactic acid) increased the LOI (limiting oxygen index) of PLA from 21% to 38%. Neat PLA burns rapidly, with considerable burning drips and does not self-extinguish. With 15% PA-B is immediately self-extinguishing and achieves UL94-V0 @ 3 mm. The flame retardant mechanism is identified as pyrolysis of the banana peel materials by phosphoric acid to generate dense char (11% char by weight @ 550°C with 15% PA-B), release of inert gases (ammonia, water) and gas phase action of the $PO^{\cdot}$ radical.

"Eco-friendly flame retardant poly(lactic acid) composites based on banana peel powders and phytic acid: flame retardancy and thermal property", F-b. Kong et al., J. Polymer Research (2020) 27: 204
https://doi.org/10.1007/s10965-020-02176-4



ATH from secondary materials

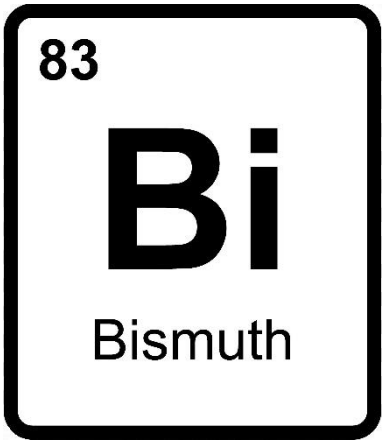
Aluminium trihydroxide was produced from anodisation residues and demonstrated as a PIN flame retardant in polyethylene. Anodisation of aluminium items uses an acid bath to generate a corrosion resistant surface. Waste from a Brazil aluminium plant was a humid solid. This was dissolved in sodium hydroxide, then aluminium trihydroxide was precipitated by dosing hydrochloric acid. This generated ATH nanoparticles (< 50 nm) with c. 45% crystallinity and a filamentous morphology. 0 to 6% of this ATH was tested as a PIN flame retardant in LLDPE (low linear density polyethylene). 6% ATH reduced the horizontal burning rate of LLDPE from 46 mm/s (neat) to 27 mm/s. The authors conclude that this process could potentially recover aluminium from this industrial waste stream as a useable PIN flame retardant.

"Synthesis of aluminum hydroxide nanoparticles from the residue of aluminum anodization for application in polymer materials as antiflame agents", F. Kuball Silva et al., J. Mater. Res. Technol. 2020 ; 9(4): 8937–8952 https://doi.org/10.1016/j.jmrt.2020.05.108

Research into reactive PIN FRs

Looking for solvent-free, low toxicity, reactive phosphorus PIN flame retardancy for polyamide (PA6). A reaction-extrusion process was tested to generate phosphorus-containing modified polyamide, containing also phosphorus oligomers. This was then melt-spun to textile fibres, then tested for fire performance and phosphorus leaching. The inputs to the solvent-extrusion were DVPPO (divinyl phenyl phosphine oxide) and piperazine (which contains N), generating phosphine oxide macromolecules which largely reacted onto the PA6 polymer molecules (cross-linking) and a final P content of 0.73% w/w. The phosphine oxide macromolecules provided a lubricating effect, but tensile strength of the P containing PA6 was somewhat lower than neat PA6. The treated PA6 showed zero leaching in water of phosphorus (after 16 hours) from the treated PA6. After pressing into 1 mm plates, fire tests showed that the treated PA6 had a +20% higher LOI, and 50% reduced vertical burn, with afterburn reduced from 18 to 1 second. ROS (reactive oxygen species) in vitro testing of the DVVVPO suggested low toxicity.

"Michael addition in reactive extrusion: A facile sustainable route to developing phosphorus based flame retardant materials", P. Simonetti et al., Composites Part B 178 (2019) 107470 https://doi.org/10.1016/j.compositesb.2019.107470

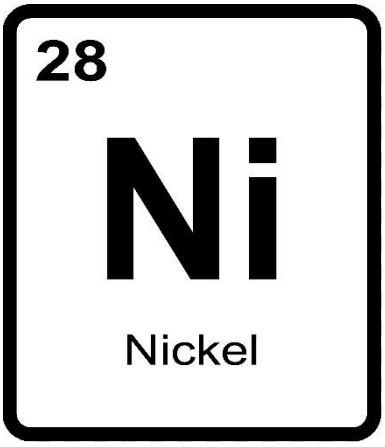


Bismuth – phosphorus nitrogen PIN synergy

A molecule combining bismuth with melamine phosphate shows synergistic fire and smoke reduction in epoxy. Phosphoric acid was reacted with pentaerythritol, then with melamine, then with bismuth oxide (Bi_2O_3, 10% w/w) and additional melamine. The resulting PPMS-Bi [1], and also PPMS (not reacted with bismuth) was tested as a PIN flame retardant in epoxy – polyamide (2:1) resin at FR loadings of 20 – 40%. The neat resin was not rated under UL94, whereas with 30% PPMS or 30% PPMS-Bi a rating V0 (4 mm) was achieved. Peak heat release was reduced by around 75% with 40% PPMS, and by around 85% with 40% PPMS-Bi. Smoke density was around 30% lower with PPMS-Bi than with PPMS only, and was also lower with PPMS-Bi than with PPMS and bismuth oxide added separately to the resin. EDS [2] suggests that the hydrogen bond linking of the bismuth interacts with phosphorus to generate continuous, compact and intumescent char formation.

[1] pentaerythritol phosphate melamine salt hybrid bismuth oxide
[2] EDS = energy-dispersive X-ray spectrometry

"Synergistic effect of bismuth oxide and mono -component intumescent flame retardant on the flammability and smoke suppression properties of epoxy resins", Z. Xu et al., Polym Adv Technol. 2019;1–11,
https://doi.org/10.1002/pat.4744



Nickel ammonia phosphate

Research shows that the PIN chemical $NiNH_4PO_4{\cdot}H_2O$ can reduce flammability and smoke emission from epoxy resin. Three different nano-morphologies of nickel ammonia phosphate (NiAP) were synthesised in a one-step precipitation reaction, then tested in 0 – 7 % loading in epoxy. LOI (limiting oxygen index) was increased from 25% to 35% with 5% NiAP, peak heat release rate (PHRR) is decreased by more than two thirds and smoke production rate is reduced by 22 -34 %. Three morphologies were produced: needles, nanosheets (c 20 -40 µm sheet dimensions x 100 - 300 nm thickness), and agglomerates of the sheets. The authors suggest that the morphology of the NiAP is important, with the nanosheets being most effective as FRs: however, the differences for LOI and PHRR are (very) small, and somewhat larger only for smoke emission. pinfa notes that possible toxicity risk of nickel should be verified before development of such a use.

"Investigation of nickel ammonia phosphate with different morphologies as a new high-efficiency flame retardant for epoxy resin", W. Zhang et al., High Performance Polymers 2020, 1–12
https://doi.org/10.1177/0954008319867369

CHEMICAL INDUSTRY

Cefic new President

Dr. Martin Brudermüller, Cefic's new President, will lead to deliver on Green Deal objectives. Dr Brudermüller is CEO of BASF (a pinfa member company) and has more than 30 years' experience in various roles in the chemical industry. His strong belief in cooperation with stakeholders will help Cefic to continue to act as a dialogue partner with the European institutions and societal actors. Marco Mensink, Cefic's Director General, thanked Daniel Ferrari, CEO of Versalis (Eni) and President of Cefic since 2018, for his excellent leadership and for his constant efforts to balance the industry's competitiveness with a drive to support the transition and to enhance the sustainability agenda. This resulted in the publication of Cefic's Mid-Century Vision.

"BASF CEO Dr. Martin Brudermüller elected new president of Cefic", 15th October 2020 https://cefic.org/media-corner/newsroom/basf-ceo-dr-martin-brudermuller-elected-new-president-of-cefic/

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