pinfa
Phosphorus, Inorganic & Nitrogen Flame Retardants Association

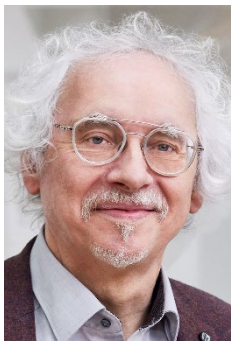
Your newsletter for non-halogen fire safety solutions n° 142 October 2022

SPE Flame Retardant Week 2022

The National Week of Flame Retardants, organised online by SPE (Society of Plastics Engineers) and pinfa-NA attracted over one hundred participants for five online sessions 22nd – 26th August. The Week was opened by **Carolyn Pressley (Budenheim), pinfa-NA Chair**, and **Maggie Bauman (FRX Polymers), pinfa-NA Vice Chair and Technical Program Chair of the SPE Non-Halogenated Flame Retardant Technical Interest Group**.

Introduction to fire safety in polymers

Roger Avakian, Avakian Polychem Consulting, **provided a one hour introduction to polymer fire safety**, presenting the different principal non-halogenated flame retardant chemistries and how they function to prevent or inhibit fire and summarising key fire performance tests. He introduced the challenges of polymer – flame retardant compositions, including compatibility with processing, fire performance objectives, compatibility with other material performance qualities, durability in application (e.g. weathering), cost (taking into account loading needed) and chemical regulatory constraints (TCSA, REACH, customer chemical specifications …). Tips concerning information sources were provided: use suppliers' information but also independent sources (science literature, pinfa application brochures) to understand the inherent properties of different FRs (fire mechanism, migration, effect of water); watch videos of fire tests (not just numbers) to understand fire behaviour; consider combining PIN FRs and synergists; initial small scale testing of fire performance but also processing re-processing (recyclability).



Rudolf Pfaendner, Fraunhofer LBF (Institute for Structural Durability and System Reliability) presented non-halogenated FRs which can function in the gas phase (radical generators). This can provide fire inhibition action complementary to char-producing (solid phase) PIN FRs, In particular, he discussed nitrogen and sulphur compounds such as AZO, triazenes, sulfides. He presented developments with oxyimides, which have shown to be effective as PIN FRs alone in some polymers, as synergists with other PIN FRs or can be combined as P or S derivates or metal salts. See Speiss et al. 2021. Oxyimides offer an alternative to ATO (antimony trioxide).

PIN FR supplier presentations

This SPE event included a session of PIN FR product presentations by pinfa-NA members, showing a range of different PIN FR solutions able to achieve high levels of fire performance in many different polymers:






- **Paul Hardy, Amfine**
- **Tobias Moss, Budenheim**
- **Elke Schlosser & Subra Narayan, Clariant**
- **Maggie Baumann, FRX Polymers**
- **Qingliang He, Lanxess**
- **Kerry Smith, Nabaltec**

Regulatory and testing

Tim Reilly, Clariant, summarised regulatory developments in the USA, underlining that this is largely driven by NGOs, often via political action in one or a few States. Federal action has mainly targeted "PBT" chemicals (Persistent, Bio-accumulative, Toxic), concerning a number of brominated FRs. States have different approaches, ranging from positions against nearly all FRs (e.g. New York, pinfa Newsletter n°135) to more measured assessments of different FRs, fire safety and applications (Washington, pinfa Newsletter n°140). Increasingly, NGOs argue that the only way to ensure FR safety, in particular in recycling, is to move to FRs with low hazard properties. In conclusion, FR users should anticipate regulatory developments, avoid any FR which is possibly PBT or with problematic hazard properties (health or environment risks) and use 3rd party chemical hazard data to support this selection (e.g. US EPA, GreenScreen, ChemFORWARD)

James Zhou, Avient, summarised fire testing, noting that there is not one best test, but a range of tests for different fire behaviours of materials: thermal degradation, ease of ignition, ease of extinction, dripping and flaming droplets, flame spread, heat release rate, fire endurance, smoke emission, toxic gas emission and char formation. Correlations between different fire tests, in particular small-scale to larger-scale, were discussed. New developments in standards include fire tests for EV batteries and the wildland – urban interface.

Lauren Heine, ChemFORWARD, presented the NGO's globally harmonised repository of chemical hazard assessment data (see pinfa Newsletter n°141). This provides readily accessible and useable information on chemical ingredients identified by EC and CAS number and/or by trade name, reviewed by toxicologists and peer-challenged, for downstream users. Such information is necessary to respond to criteria such as EPEAT (Global Electronics Council: Electronic Product Environmental Assessment Tool) which represents over 2 billion US$ annual purchasing (specified by US Federal Executive Order). EPEAT is currently working to reduce chemicals of concern, in particular certain flame retardants, plasticisers and PFAS.

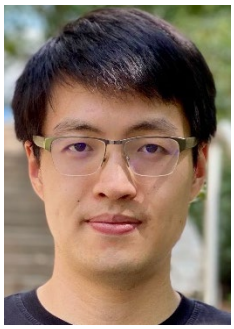
Panel discussion moderated by Scott Marko, SPE (Society of Plastics Engineers), the speakers, Anteneh Worku, FR Adviser and Steve Scherrer, Lanxess, answered participant questions on different PIN FRs and on appropriate fire tests for different applications. On regulatory questions, the panellists emphasised that there are many information sources, including regulatory agencies, 3rd party organisations (see above), pinfa www.pinfa.eu and importantly FR suppliers (including on safety data sheets).

Recycling

Sabyasachi Gaan, EMPA (Swiss Federal Laboratories for Materials Science and Technology), outlined developments in recycling of FR thermoplastics and thermosets. Thermoplastics (PET, PE), due to their linear structure, are relatively easy to recycle via mechanical means, but mixing of different classes of polymers, additives and contamination complicates the recycling process. Depolymerisation seems today feasible for polyester, polyamides, polyurethane, but difficult for other thermoplastics. The only currently feasible solution for thermosets is pyrolysis to hydrocarbon feedstock or fuels. There is very little published literature on recycling of FR polymers. Recycling of polymers containing PIN FRs has been demonstrated, however the recycling process does compromise the long term mechanical performances of the polymer. ATH (aluminium trihydroxide), a common flame retardant, has been shown to catalyse depolymerisation of PLA (poly lactic acid). In recent work, a DOPO derivative was shown to inhibit polyester degradation in a mechanical recycling process (see Goonie 2019, Bascucci 2022 in pinfa Newsletter n°136). The work by Fraunhofer LBF with pinfa also demonstrates compatibility of several PIN FR – polymer combinations with mechanical recycling. A possible route to address the difficulties of recycling thermosets may be vitrimer materials (see pinfa Newsletter n°139) and PIN flame retardancy can be built into these (inclusion of P or N).

In discussion it was noted that PIN FRs can be an obstacle to recycling if they are not durable during the recycling process. For mechanical recycling, this should not be a problem as FRs are designed to resist the extrusion or injection conditions of the polymer in which they are used. For chemical recycling or pyrolysis, this must be addressed case by case.

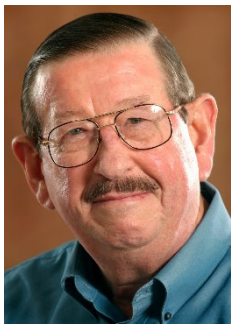
Looking for non-halogenated anti-drip



Yiming Zhang, Case Western Reserve University, **discussed possible alternatives to PTFE to prevent melt-drip**. PTFE (PTFE (polytetrafluoroethylene, a PFAS chemical) is widely used at low doses to prevent melt-drip of polymers in fire, in particular for PIN-FR thermoplastics. Polymer dripping in fire results from melting (above polymer glass temperature Tg) and polymer decomposition. Burning drips in fire can spread the fire. Melt-drip therefore causes failure of V-0 in UL 94 fire performance testing. In fire, PTFE causes shear-induced fibrillation, effectively entangling the polymer molecules, preventing melt-dripping, and is effective at doses of only 0.5% wt. Many PIN FRs somewhat reduce melt-dripping, e.g. by physical structure (mineral fillers) or by generating char, but these effects require high loadings or are insufficient to achieve UL 94 V-0. Some PIN FRs or PIN synergists do however show potential to be more effective through specific effects on the polymer during fire melt and decomposition: by ceramification (e.g. Tolsa, pinfa member, nano mineral silicates, by causing cross-linking of polymers; Paxymer carboxylic and acrylate polymers, silicones, …) or by generating porous particles which help maintain polymer structure (e.g. zinc borate). These specific PIN FRs have proved able to achieve UL 94 V-0 in certain polymers at 1 – 2 % wt.

Bio-based flame retardants

Kari Ingalls, Tidal Vision, **presented the company's chitosan products, sourced from seafood processing wastes** (crab shells), which have many applications including as PIN flame retardants. Chitosan is the second most abundant biological polymer, is positively electrostatically charged, contains nitrogen and carbon, and has reactive amine and hydroxyl groups enabling binding of phosphorus or other PIN FR elements. Tidal Vision extracts and purifies chitosan from seafood wastes, to specific specifications (e.g. molecular weight range) appropriate for different industrial applications. The remaining 80% of organic-rich biomass is recycled as fertiliser. Many research studies show the potential of chitosan and derivates as PIN FRs. Aqueous application to textiles provides effective flame retardancy but is not wash durable, and cross-linking solutions are being developed to address durability.



Bob Howell, Central Michigan University, **outlined a range of materials from which PIN flame retardants can be biosourced**: tartaric acid, chitosan, castor oil, plant-based phenolics, glycerol / adipic acid, starch derivatives … These can be modified to produce both additive or reactive PIN FRs, and can be reacted with phosphorus to produce high performance PIN FRs which are stable in polymers but are biodegradable.

FIRE SAFETY

Changsa China skyscraper façade fire

One side of the 42-storey China Telecom building rapidly engulfed in flame in presumed façade cladding fire. Media reports suggest that the cause may have been a fault in an aircon unit or lighting. Official media indicate no casualties and that the fire was rapidly brought under control. Videos online show the fire spreading from near the bottom of the building, with much black smoke, but maybe it simply burnt itself out by consuming all the flammable external material. The fire is seen covering the whole of one side of the 42-storey building, but does not spread to the adjacent sides. Authorities report no casualties. Media have suggested the cause may have been an air conditioning system. External cladding systems have recently been banned or restricted on tall buildings in a number of Chinese cities, including Shanghai, but this may be related to risk of falling materials not to fire.

EU plans wildfire preparedness

The European Commission and Council have outlined the need for increased wildfire action in the face of climate change risks. At an informal meeting 5th September, EU Member States, the commission and the Czech Council Presidency gave tribute to firefighters' engagement against the exceptional fires of 2022. They noted that climate change is rapidly altering fire risk, with fires now in central and northern Europe. A new fleet of over 20 EU firefighting aircraft will arrive from 2026 but today the intensification of wildfires exhausts current firefighting capacities. Announcements include additional investment in firefighting aircraft, pre-positioning of firefighters on the ground across Europe in the Spring and improved coordination and planning. The European Commission further announced a 170 million € budget for the "resCUE" fleet on 5th October.

FR edition of the Handmaid's Tale

Fire resistant publication of Margaret Atwood's book is a protect against book-burning, censorship and anti-abortion.. The launch video shows the book resisting a flame thrower. The publisher, Penguin Random House said "In the US and around the world, books are being questioned, banned and even burned". The unique FR edition was auctioned at Sotheby's and sold for 130 000 US$ for the benefit of PEN America. The book includes heat shield foil, nickel wire sewing, FR paper and a FR phenolic cover. The Handmaid's Tale, a futuristic dystopian novel, has faced repeated censorship.

"The Unburnable Book". A book that fights censorship.
https://unburnablebook.com/

Flammable acoustic foam blamed again

23 people died in a nightclub fire in Thailand, with flammable foam blamed for the rapid fire spread. The fire on 4th August in the MountainB nightclub, Chonburi Province, 150 km from Bangkok, is stated to have been accelerated by flammable soundproofing foam on walls which took firefighters three house to bring under control. Emergency exits are said to have been locked and the club had no operating licence. This follows fires at the Santika Club, Bangkok, 2009, which killed 67 people and injured over 200.

32 people died in the An Phu karaoke parlor fire, Binh Duong, Vietnam, 6th September 2022, where again soundproof foam, along with wooden interiors, is cited as responsible for the deaths.

Vancouver warns of battery fire risks

Vancouver City fire services say lithium ion batteries have caused 5 fire deaths this year with battery fires are increasing. Five out of seven fire deaths in the city by June 2022 were caused by batteries, with five times more battery fires occurring than in 2016. A recent fatal fire is attributed to an overcharged e-bike battery. Fires are caused by modifications to batteries or electrical devices, battery damage, damaged chargers and leads or cut-price batteries.

"Vancouver sees 5-fold increase in fire deaths caused by exploding lithium-ion batteries ", 13th June 2022 https://www.pentictonwesternnews.com/news/vancouver-sees-5-fold-increase-in-fire-deaths-caused-by-exploding-lithium-ion-batteries/

US initiative for building codes

Biden-Harris administration launches action to modernise and implement building safety and energy codes across the US. The initiative aims to help State and local governments adopt the latest building codes (in effect, the ICC Residential and Building codes IRC and IBC). The initiative will include implementing codes in federally subsidised local housing and other building projects, "above code" realisations for federal buildings and funding to support local adoption and implementation of codes. The announcement of the initiative cites resilience to flooding, hurricanes and wildfires, and energy savings, but upgrading US implementation of building codes would also lead to higher fire safety standards in many States and jurisdictions.

"Fact sheet: Biden-Harris Administration Launches Initiative to Modernize Building Codes, Improve Climate Resilience, and Reduce Energy Costs", 1st June 2022 https://www.whitehouse.gov/briefing-room/statements-releases/2022/06/01/fact-sheet-biden-harris-administration-launches-initiative-to-modernize-building-codes-improve-climate-resilience-and-reduce-energy-costs/

GOV.UK

UK extends ban on combustible cladding

Combustible cladding is banned on high rise buildings and non FR polyethylene composite panels on all new buildings. The UK Government's revision of fire safety guidance is part of an ongoing tightening of building regulations following the Grenfell fire. As well as requirements on fire service information on buildings and evacuation alert systems, restrictions on combustible materials in or on external walls are extended. The already announced ban on combustible materials in new residential buildings over 18m high is extended to hotels, hospitals and certain other buildings. Combustibility is restricted for materials in or on external walls for residential buildings 11 – 18 m. Metal Composite Material panels (MCM) with non fire-safety treated polyethylene core are banned on all new buildings of any height.

"Fire safety guidance strengthened for new high-risehomes", UK Government, 1st June 2022 https://www.gov.uk/government/news/fire-safety-guidance-strengthened-for-new-high-rise-homes

Fires more likely in social housing

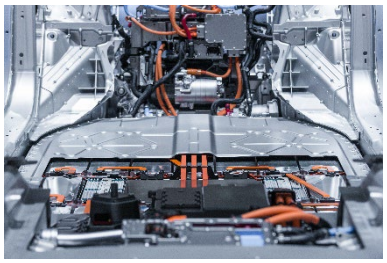
New South Wales Australia shows nearly 44 000 residential fires in ten years, with higher incidence in social housing. The study, using nine data sources, covered all fires reported to fire services in NSW (population c. 8 million) 2005-2014. Over this period, 43 700 residential fires were reported, of which 5070 were in social housing (11.6%), that is a 20% higher occurrence in social housing taking into account the proportion of such housing. Fires in social housing were particularly caused by smokers' materials. The fatality rate for social housing fires was no higher than for other housing fires, but the injury rate (health service intervention) was 16% higher. Nearly 90% of social housing fires over this period were in buildings with no functioning smoke alarm, but this proportion did fall slightly over the ten years.

"Comparison of causes, characteristics and consequences of residential fires in social and non-social housing dwellings in New South Wales, Australia", Ghassempour et al., Preventive Medicine Reports 28 (2022) 101860 https://doi.org/10.1016/j.pmedr.2022.101860

Insurance company warns of e-bike fires

AXA UK warns of increasing fire risks from lithium-ion batteries in electric bicycles and e-scooters. AXA UK has covered nearly half a million UK£ losses on claims caused by such batteries. The insurer says such fires are increasing exponentially and usually occur in residential buildings. Battery fires are particularly linked to damaged batteries, over-charging or batteries exposed to extreme temperatures. The London Fire Brigade is cited stating that e-bike and e-scooter batteries burn "with ferocity" and that such fires "develop so rapidly the situation can quickly become incredibly serious".

"Insurance firm predicts rise in lithium-ion fires from e-bikes and scooters", 23rd August 2022 https://internationalfireandsafetyjournal.com/insurance-firm-predicts-rise-in-lithium-ion-fires-from-e-bikes-and-scooters/



Review of flame retardants for battery safety

Overview of battery fire risks, flame retardant solutions and technology perspectives. **60 pages. 125 references**. Current lithium-ion batteries stock up to 250 Wh/kg of energy, but this could in theory increase to 3 500 Wh/kg, so increasing fire and explosion risks. Most lithium-ion batteries use polymer separators (e.g. polyethylene, polypropylene) and organic solvent electrolytes or solid polymer-based electrolytes, all of which are flammable. The review indicates that phosphorus-based FRs, either additive or reacted into polymers, can reduce fire risks of electrolytes, including in combination with inorganics (e.g. aluminium, boron). Phosphorus FRs are also effective in reducing flammability of separators, including in combination with nitrogen, sulphur, silicon and/or metal oxides. Fire safety of battery cell and pack enclosures, cables and other parts can also be ensured by appropriate use of PIN FRS.

"Recent progress in flame retardant technology of battery: A review", W. Liu et al., Chemicals and Materials (2022), https://doi.org/10.1016/j.recm.2022.07.005

REGULATION

US EPA risk determination of HBCD cluster

Evaluation concludes cyclic aliphatic bromide FR chemicals present unreasonable risk for health and the environment. The US federal Environment Protectional Agency (EPA) final risk determination covers the cluster of cyclic aliphatic bromide chemicals, including the brominated flame retardant hexabromocyclododecane (HBCD). EPA notes that HBCD has been completely replaced in the US. It is also banned in Europe as POP (persistent organic pollutant). The "whole chemical" risk determination "finds that HBCD presents an unreasonable risk of injury to human health and the environment when evaluated under its conditions of use", driven by risks from import, processing, recycling, commercial use, and disposal. EPA will now propose federal regulatory action.

The EPA "whole chemical" approach makes a safety determination which does not differentiate between uses requiring further risk management measures from those which do not, so effectively considering that if some conditions of use pose risk then all uses should be regulated.

"Risk Evaluation for Cyclic Aliphatic Bromide Cluster (HBCD)", US EPA, June 2022 https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/risk-evaluation-cyclic-aliphatic-bromide-cluster-hbcd

US EPA "whole chemical" approach under TCSA https://www.epa.gov/newsreleases/epa-announces-path-forward-tsca-chemical-risk-evaluations

RECYCLING

Finland lists problem FRs for recycling

Report for Business Finland lists 25 problematic or potentially problematic (under assessment) flame retardants, of which 21 are halogenated FRs and four are organophosphorus FRs : trixylyl phosphate (TXP), triphenyl phosphate (TPP = TPhP), tricresyl phosphate (TMPP), Isolpropylated triphenyl phosphate (IPTP). Perfluorinated substances (PFOA, PFHxS), phthalates and (especially) heavy metals are also identified as problematic. The report notes that additives are needed to provide special properties for plastics in electronics, but that restricted chemicals can prevent recycling, which means trying to avoid using chemicals now which might be restricted in the future. The report indicates that the most relevant emerging chemicals are the "substitute" brominated FRs, but also certain organophosphorus FRs "even though they are considered less persistent and less toxic in the environment than halogenated FRs."

"Harmful additives in WEEE plastics and the regulatory framework", P. Fjäder et al., SYKE (Finnish Environment Institute), for Business Finland ALL-IN for Plastics Recycling PLASTin project, ISBN 978-952-11-5507-9, report n°33, 2022

CONSULTATIONS AND COMMUNICATIONS

FRPM call for abstracts open to 31/12/2022

Call for abstracts for leading flame retardant research conference Fire Retardant Polymeric Materials is now open. FRPM will take place in Dubendorf (EMPA), Switzerland, 26-29 June 2023.

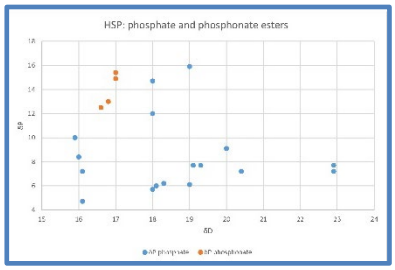
Call for abstracts, open to 31st December 2022 www.frpm-23.org

EU consultation on Ecodesign for PV

Public consultation open to 16/12/2022 asks whether to develop Ecodesign for PV panels. Safety is not mentioned. The previous 'roadmap' (inception impact assessment) mentioned health and safety, but these are not raised in the public questionnaire which addresses energy efficiency and labelling, durability, repairability, recycling and carbon footprint. In addition to the questionnaire, stakeholders, companies and individuals can submit position papers or other documents.

"Energy labelling – European Commission to examine need for new rules on environmental impact of photovoltaics", EU public consultation open to 16th December 2022 https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12819-Ecodesign-European-Commission-to-examine-need-for-new-rules-on-environmental-impact-of-photovoltaics_en

REPORT FOR PINFA



Science-based grouping of phosphorus FRs

pinfa publishes report on possible property-based REACH regulatory grouping of organophosphorus flame retardants. The 60 page assessment was commissioned from chemical science and risk expert, Peter Fisk (Green Chemical Design). The report notes that sometimes all organic phosphorus flame retardants (OPFRs) are considered to have similar health and environmental hazards, but that there is no solid basis for this. OPFRs have different physical-chemical, toxicological, ecotoxicological and environmental fate properties, based on many reliable studies included in the publicly available REACH dossiers. Any grouping should be based on scientific methodology. Six main groups are proposed based on molecular structure, physico-chemical properties and octanol-water partition coefficient (K_{OW}, an indicator of whether the substance is water soluble), which are generally consistent with ecotoxicology: Trialkyl phosphates, Triaryl phosphates, Monoalkyldiaryl phosphates, Chloroalkyl phosphates, Bisaryl phosphates, Phosphonates. Toxicological properties can however differ within certain of these groups, so that substances with specific structures may need to treated separately, and certain OPFRs do not fit into any of these groups. Extrapolation from one group to another is not feasible and not scientifically justified.

"Report for pinfa: Grouping of organophosphorus flame retardants in the context of REACH", Peter Fisk, Green Chemical Design, 21 July 2022 https://www.pinfa.eu/wp-content/uploads/2022/08/P-Fisk_organophosphorus_flame_retardants_grouping_for_pinfa_2022-07_final.pdf

RESEARCH AND INNOVATION

Mineral synergists for intumescent PIN FRs

Pinfa member IMERYS has launched a range of mineral flame retardant (FR) synergists for engineered thermoplastics. The synergists are morphologically and chemically engineered for use in thermoplastics. Each product provides unique performance enhancing properties in addition to the synergistic behaviour. Benefits include improved UL94 classification, rheology, dimensional stability, reinforcement and improved processing (reduced equipment corrosion) - all while reducing the loading of FRs and other additives. Applications include, electrical and electronics, appliances and electric vehicles.

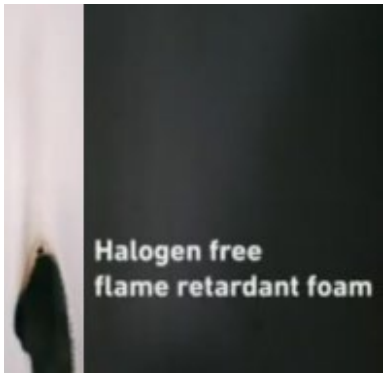
"IMERYS releases new product: ImerShield™ Flame Retardants", 1st August 2022 https://www.prnewswire.com/news-releases/imerys-releases-new-product-imershield-flame-retardants-301596992.html

Sports EV cooling element of PIN FR nylon

German sports electric car uses Lanxess (pinfa member) non-halogenated flame retardant nylon for charger heat dissipation. The charging system manufacturer is Leopold Kostal GmbH, Luedenscheid, Germany, a global automotive, solar and electrical contact system supplier. Up to 48 amps flow through plug contacts in the controller during EV battery charging. The PIN FR nylon 6 compound uses a special mineral filler to conduct heat, so avoiding overheating. The compound also offers reliable electrical insulation (CTI A 600) and fire resistance (UL 94 V-0 0.75 mm) to ensure safety. Mechanical performance, dimensional stability and good flowability enable production of intricate, miniaturised components. The heat-conductive PIN FR nylon compound also has applications in EV battery systems and heat exchangers and mounting plates for electronics.

See also Lanxess nylon compounds in pinfa Newsletters n°s 129, 119, 62.

"Giving heat the cold shoulder. Cooling element made from PA6 for the charge controller of an electric sports car", Lanxess press release, 9th July 2022 https://lanxess.com/en/Media/Press-Releases/2022/06/Giving-heat-the-cold-shoulder



Sekisui Alveo launches PIN FR foams

The specialist in polyolefin foams has launched non-halogenated FR versions of Alveolit TA and TL foams. Sekisui Alveo, Switzerland, is a world leader in cross-linked polyolefin foams, particularly in roll formats, for applications such as transport door seals and interiors. The company is part of the Japan-based global Sekisui group, developing solutions in plastics since 1940. Sekisui Alveo's new PIN FR formulations achieve EN 13501-1 vertical fire behaviour and FMVSS horizontal fire behaviour, for use in automotive, electronics and equipment. In flammability testing, the toxicity of smoke emitted by the new PIN FR foams was much lower than for foams containing halogenated FRs or antimony trioxide (CIT conventional index of toxicity), and smoke was white, so improving visibility. The company also underlines that the absence of halogenated FRs or heavy metals enables to meet recyclability and "Material Health" requirements.

"New foams meet stringent sustainability requirements", 8/2021 https://www.sekisuialveo.com/en/news-media/new-foams-meet-stringent-sustainability-requirements-n382 and test video https://www.youtube.com/watch?v=i9p1n_V2Qls

2-hour fire-rated power cables are PIN

Radix launches 600V cable, UL 2196 (2 hours) to ensure system reliability in a fire, using non-halogen flame retardants. The LSZH (low smoke zero halogen) DuraLife® RHH cable and ancillary components achieve 2-hour fire resistance, ensuring functional electrical continuity, in both vertical and horizontal installations up to 4 cables per conduit. This can ensure that systems such as lifts, fire pumps, ventilation and emergency lighting continue to function in case of a fire in high-rise buildings, hospitals, mass assembly buildings, etc. The cable is easy to install and available in a range of lengths and diameters 45 – 130 mm. It is certified UL 2196 (2 hours), UL FHIT 28E, UL 44 type RHH and meets NFPA 70 (art. 517, 695, 700, 708 & 660) and NFPA 130 and 502 with AHJ approval.

"Radix Announces New Duralife RHH Two-Hour Fire-Rated Power Cables", 11 January 2022 https://www.radix-wire.com/radix-blogs/radix-announces-new-duralife-rhh-two-hour-fire-rated-power-cables/?category=Radix%20News and Radix Wire & Cable https://www.radix-wire.com/products/fire-rated-cables/new-duralife-rhh-power/

Comparison of PIN FR systems in ABS

Various combinations of fourteen different PIN flame retardants were tested for fire performance and smoke emission in ABS. Samples of ABS (acrylonitrile butadiene styrene) were injection molded with 20% total loadings of PIN FRs including aluminium diethylphosphinate (AlPi), ammonium polyphosphate (APP), melamine polyphosphate, melamine poly(zinc phosphate), melamine, nanoclays, expanded graphite, zinc borate and molybdate magnesium silicate. These PIN FRs were selected as not showing environment or health concerns as used. UL 94 V-0 (4 mm) was achieved with AlPi + APP and inclusion also of expanded graphite enabled a further reduction of peak heat release rate (pHRR) and of smoke emissions. The authors conclude that AlPi + APP (with anti-drip agent) achieves better fire performance than standard brominated flame retardant (as tested) with -40% lower pHRR. Inclusion of expanded graphite or molybdate were effective at reducing smoke emission. Impact resistance was however lower than with the brominate FR, requiring further investigation.

"Systematic evaluation of bromine-free flame-retardant systems in acrylonitrile-butadiene-styrene", A. Bachinger et al., J Appl Polym Sci. 2022;139:e51861 https://doi.org/10.1002/app.51861

PIN FRs for sustainable construction

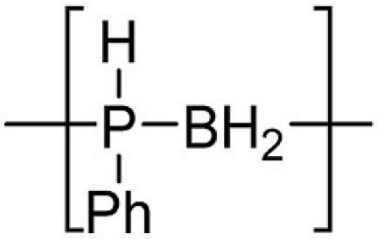
All The Shapes Tile & Co. eco-friendly material innovation hub, Liverpool, features PIN flame retardant fire-safe timber. ATS' main showroom will use MEDITE's flame retardant OSB (orientated strand board) timber panels, using water-based, non-halogenated, formaldehyde-free fire safety treatment. These provide EN 13501-1 B-s2, d0 and Bfl-s1 (flooring) fire classification, the highest fire rating achievable by wood panels, reducing fire spread in buildings and increasing safety during construction. They are suitable for public places, fire escape routes, etc. They are light-weight, easy to cut, resistant, moisture resistant, and use FSC® certified timber and are certified carbon positive (more carbon stored in the product than emitted during manufacture).

"Fire safety meets style in new Liverpool Materials Lab", 6th July 2022. Stoneybatter office building case study. MEDITE green fire resistant timber panels:

Natural seaweed boron for fire safety

Researchers propose bio-based "plasterboard" for building, with natural boron PIN fire safety and carbon benefits. Seaweed grows up to 50 cm per day and sequesters nearly 200 million tonnes of carbon annually. It is easy to cultivate and does not compete with food production. Research at University of Canterbury, New Zealand, propose a biocomposite wall panel using seaweed (algae) which is claimed to offer moisture absorption and release ensuring warmer and more comfortable homes, and to offer commercial-level fire resistance because of boron naturally present in the seaweed. It offers a flowy surface, green, red or brown colour depending on the species of seaweed used, and can be recycled at end-of-life as a fertiliser.

"New seaweed plasterboard design provides safer, more sustainable building option", 20th January 2022 LINK.

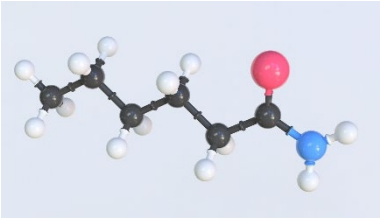


Polyphosphinoboranes as PIN FRs

New class of polymeric phosphorus- and boron-based PIN FRs synthetised and fire tested on cotton at lab scale. Poly(phenylphosphinoborane) was synthesised by dehydropolymerisation of phenylphosphine-borane using an iron-based pre-catalyst in toluene, in a process considered scalable. This resulted in a polymer with a backbone of - P (H, -Ph) - BH_2 - (Ph = phenyl), isoelectronic with polyolefins. This was applied (in solvent) to cotton samples by pipette, then dried at 40°C. The polyphosphinoborane application rendered the cotton self-extinguishing and charring, and was not removed by soaking in water. Replacing the H attached to P in the polymer backbone by a fluorinated or a C_6H_{13} group did not significantly modify the fire performance, suggesting that flame retardancy was due to the P and B in the polymer backbone.

The authors suggest that polyphosphinoboranes have potential as non-leaching, chemically tuneable, polymeric PIN FRs.

"An investigation of polyphosphinoboranes as flame-retardant materials", A. Knights et al., Polymer 247 (2022) 124795 DOI LINK.



DOPO – N PIN FR for polyamide

A phosphorus – nitrogen PIN flame retardant was developed for PA6 providing gas phase fire performance and anti-drip. 'CBPB' was synthesised by reacting p-Cyanobenzaldehyde (CBAD with 2-aminobenzimidazole (2-AB), then with 9,10-dihydro-9-oxa-10-phosphaphenanthrene-10- oxide (DOPO). CBPB offered improved thermal stability compared to DOPO and a melt processing temperature (T_p) close to that of PA6. 8% loading of CBPB reduced peak heat release rate of PA6 by nearly 20% and increased LOI by nearly 50%, enabling UL 94 V-0 (3 mm) and self-extinguishing (in 4s), nearly no drips for extruded PA6 fibres. Smoke release was however increased, indicating that the FR effect was in the gas phase. The anti-drip effect is considered to be by cross-linking by trimerization of nitrile groups at c. 290°C, that is lower than the initial degradation temperature ($T_{5\%}$) of PA6 which is c. 350°C.

"A phosphorus-containing flame retardant with thermal feature suitable for polyamide 6 and its filaments with enhanced anti-dripping performance", Y. Sun et al., Polymer Degradation and Stability 200 (2022) 109936 https://doi.org/10.1016/j.polymdegradstab.2022.109936

OTHER NEWS

EU committees favorable opinions on proposed restriction for Dechlorane Plus. The EU's Committee for Socio-Economic Analysis (SEAC) has adopted an Opinion supporting Restriction (under REACH) of the chlorinated flame retardant Dechlorane Plus (Dodecachlorododecahydrodimethanodibenzocyclooctene). The Committee for Risk Assessment (RAC) already adopted an Opinion in favour of restriction in March 2022. The final decision will be taken by the European Commission through committee procedure. The proposed restriction would concern manufacture, use and placing on the market of Dechlorane Plus as a substance or included in product and articles.

PUBLISHER INFORMATION

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