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PUBLIC CONSULTATIONS



EU RoHS Directive consultation

The European Commission has opened (**to 6 December 2019**) a public consultation on "evaluation of restrictions" on hazardous substances in electrical and electronic equipment (RoHS Restriction of Hazardous Substances Directive 2002/95/EC). The RoHS Directive currently restricts (effectively bans or limits) the use of ten substances, including two classes of brominated flame retardants (PBBs and PBDEs). The consultation includes general opinion questions (importance attached to hazardous substances, willingness to pay higher prices, importance attached to repair of appliances rather than new buy, benefits of the RoHS Directive for society ...) and industry orientated questions (costs of RoHS compliance, overlaps with other legislation ...). The consultation also asks whether respondents consider that new substances should be added to the RoHS Directive with the possibility to propose substances (Q45).



EU consultation on POPs

The European Commission has opened a [public consultation](#), **to 11th November 2019**, on the EU Implementation Plan under the Stockholm Convention (POPs – Persistent Organic Pollutants). The European Commission's [accompanying document](#) reminds that the proposed update to this Plan includes adding DecaBDE (now recognised as POP) and modifying requirements for other halogenated FRs listed in the Stockholm Convention (certain other PBDEs, HBCDD, short chain chlorinated paraffins). The consultation asks the public and stakeholder for input on "old", "new" and "emerging", including "unintentional" and "in waste". Specific questions address, inter alia: alternatives, data on and identification of the brominated flame retardants HBCDD and "POP-PBDEs" (now identified to be POP), how to minimise dioxin emissions in dealing with PBDE-containing materials.

"Public consultation on the Union Implementation Plan under the Stockholm Convention 2019", open to 11th November 2019

<https://ec.europa.eu/eusurvey/runner/UIPStockholmConvention2019>



Canada Government assessment of trixylyl phosphate

Canada's federal Department of the Environment submitted for public consultation (closed 11th September 2019) an assessment of three phosphorus chemicals, including trixylyl phosphate which can be used as a flame retardant in e.g. lubricants, plastics, wires and cables, and two other phosphorus chemicals used in cosmetics and food packaging plastics. Trixylyl phosphate is labelled cat. 1B reproductive toxicity under EU CLP. The Canada Government assessment concludes that there is "low risk of harm to the environment ... not entering the environment in a quantity or concentration or under conditions that may have an immediate or long-term harmful effect ..." and also that for risk to human health "margins are considered adequate to address uncertainties in exposure and health effects ...". It is therefore proposed that no regulatory action be taken on any of the three phosphorus chemicals considered.

For information, the current status of Canada Government assessments and risk management measures for flame retardants are summarised [here](#) on one page. This shows five FRs as assessed and found not harmful to health or the environment (tributyl phosphate TBP, antimony trioxide ATO, two TBBPA bis ethers, EBTBP), fourteen FRs found not harmful but with a caution statement, fourteen FRs found harmful (all halogenated) and fifteen FRs currently ongoing evaluation.

"Phosphoric acid derivatives group", Health Canada, 12th July 2019 <https://www.canada.ca/en/health-canada/services/chemical-substances/chemicals-management-plan-3-substances/phosphoric-acid-derivatives-group.html> and "Draft screening assessment for the phosphoric acid derivatives group", Canada Gazette, part I, vol. 153, n°28, 13th July 2019 <http://gazette.gc.ca/rp-pr/p1/2019/2019-07-13/html/notice-avis-eng.html#ne2>

Canada Government summary page of flame retardant assessments "Summary of flame retardant assessments and management conducted under the Canadian Environmental Protection Act" <https://www.canada.ca/en/environment-climate-change/services/evaluating-existing-substances/summary-flame-retardant-assessments-management-conducted-cepa.html>

EU consultation on microplastics restriction

The European Chemical Agency (ECHA) launched a [public consultation](#), closed 20th September 2019, on a proposed restriction on "intentionally added microplastics". The proposed ban would cover microplastics particles where dimensions are 1 nm – 5 mm and also plastic fibres length 3 nm – 15 nm if length/diameter > 3. This would, if implemented, effectively ban the use of microplastics in any product where they are susceptible to reach the environment, with exemptions for "biodegradable" polymers (definition of biodegradability to be defined), for natural polymers (not chemically modified) and for some very specific uses. Importantly for flame retardants, the restriction would not apply if microplastics are "permanently incorporated into solid matrix" or cease to be microplastics during processing, and this could be expected to cover, for example, micro-dimensioned FR compound granules or micro-encapsulated mineral FR particles, to be confirmed.

ECHA consultation on microplastics, open to 20th September 2019 https://ec.europa.eu/growth/content/echa-public-consultation-restriction-dossier-microplastics-intentionally-added-products_en





EU tender for facade fire performance testing

The European Commission has opened a tender, to 8th November 2019 (16h), to finalise the European harmonised fire test (“alternative method” of assessment) for building façade products. The service provider should include an inter-laboratory ‘round robin’ test programme, define criteria for testing and for fire safety classification under the EU Construction Products Regulation and include a cost estimate for the proposed test method. The assessment method will cover external walls, facades and cladding systems fixed vertically (EIFS, EITCS, laminates, weather protective barriers, decorative stucco, wooden facades, metal composite materials MCMs ...). The method should implement the conclusions of the study commissioned by the EU on a new “European approach to assess the fire performance of facades” (2018) see pinfa Newsletter n°95.

“Finalisation of the European Approach to Assess the Fire Performance of Facades”, 2019/S 179-434943, EU tender open to 8/11/2019 (16h)

<https://ted.europa.eu/udl?uri=TED:NOTICE:434943-2019:TEXT:EN:HTML>

EVENTS

Fire Resistance in Plastics

Cologne / 2019

pinfa will join panel on recycling at FRiP 2019

pinfa and Flame Retardants Europe will participate in the special panel discussion on recycling and recyclability of flame retardant containing plastics, at the annual AMI ‘Flame Retardants in Plastics’ (FRiP) Conference, Cologne, Germany, 3-5 December 2019. pinfa members are also invited to the pinfa General Assembly, 3rd December, Cologne. The AMI flame retardants conferences, held annually in Europe (Cologne) and in the USA (31/3-1/4 2020 Cleveland), are industry milestones. FRiP Cologne December 2018 (see summary of all presentations and interviews in pinfa Newsletter n°98) brought together nearly 200 participants from the FR value chain and showcased developments in new FR products and applications, markets, environment, recycling, smoke emissions and smoke toxicity, and a range of applied research into new PIN flame retardant products.

AMI Flame Retardants in Plastics 2019, 3-5 December, Cologne

<https://www.ami.international/events/event?Code=C0992>

REGULATORY AND STANDARDS



New French regulations for tall building fire safety

The French Government has promulgated two decrees updating fire safety requirements for façade materials used in residential buildings of < 50 m height. The requirements depend on the height of the building, with some specifications changing for buildings > 28 m. Buildings > 50 m are covered by existing legislation for “very tall” buildings. The new regulations apply for new build and also for façade renovation work permitted from 1/1/2020. For buildings up to 50 m, all materials of façade systems must be classed at least A2-s3-d0 (“A” essentially means non-combustible), or any element which does not respect this classification must be protected by materials classified EI30. Media note that the French insurance federation (FFA) had pushed for tighter requirements (A2-s1-d0, that is very low

smoke emission). For all concerned buildings, the new regulations require that risks situated close to the façade and also the possibility of falling objects be taken into account in assessing risks. Also, insulation materials must be classed A2-s2-d0 (walls and ceilings) or A2 fl-s1 (floors) or protected by a barrier resistant to fire for 15-30 minutes. The new requirements are expected to pose challenges for the use of polymers and for wood facing in facades.

Arrêté 7th August 2019 "relatif aux travaux de modification des immeubles de moyenne hauteur et précisant les solutions constructives acceptables pour les rénovations de façade"
https://www.legifrance.gouv.fr/jo_pdf.do?id=JORFTEXT000038906954

Arrêté 7th August 2019 "modifiant l'arrêté du 31 janvier 1986 relatif à la protection contre l'incendie des bâtiments d'habitation"
<https://www.legifrance.gouv.fr/eli/arrete/2019/8/7/LOGL1907229A/jo/texte>

SCIP Database

ECHA will establish and maintain a database which will contain the submitted information on Substances of Concern in articles, as such or in complex objects (Products). ECHA will make the information in the SCIP database available to waste operators and consumers.

Information about the presence in articles of SVHCs on the Candidate List must be available throughout the whole lifecycle of products and materials, including at the waste stage. To achieve this goal, companies supplying articles that contain Candidate List substances in a concentration above 0.1% w/w on the EU market will have to submit to ECHA, as from 5 January 2021, sufficient information to allow safe use of those articles.

Data base of hazardous chemicals in articles

ECHA (European Chemical Agency) has published the information requirements for the data base of articles containing chemicals on the REACH "Candidate List" of Substances of Very High Concern (SVHC). Declaration to this "SCIP Database" will be mandatory for all concerned substances and products from 5th January 2021. Information requirements specified and published by ECHA include identification of the article, name and concentration range of the SVHC chemicals, in what material the SVHC is present (e.g. different polymers and plastics), where the SVHC is present in complex products and indications for safe use and disassembly of the article or product. Flame retardants which are on the SVHC candidate list are: Boric acid, Dechlorane Plus, Disodium tetraborate, DecaBDE, Hexabromocyclododecane (HBCDD), Short Chain Chlorinated Paraffins, Tris(2-chloroethyl) phosphate, Trixylyl phosphate, DecaBDE.

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

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



ICC rejects push for non fire safe foams in foundations

The (North American) International Code Council, meeting in August in Albuquerque, rejected a proposal to allow non flame retarded polystyrene foam in foundations, where it is underneath a concrete slab of at least 3 ½ inches. The proposal was supported by 19 persons or organisations including NGOs (including Arlene Blum's "Green Science Policy Institute"), individuals (inc. V. Babrauskas), architects' (inc. African Institute of Architects) and firefighters' organisations. The proposal is essentially the same as that adopted in January 2019 by California (see pinfa Newsletter n° 100). Despite this, the ICC committee rejected the proposal by 10 votes to 1. It will however be discussed again in Las Vegas, October 23-30. According to Bloomberg Business week, the discussion was largely about whether today's flame retardants (in particular polymeric FRs) pose health risks to building occupants.

Bloomberg Business Week 30th August 2019 <https://www.bloomberg.com/news/articles/2019-08-28/arlene-blum-s-never-ending-battleagainst-bromine>

Details of proposal RB131-19 and list of proposing organisations (see pages 177 onds.)
<https://cdn-web.iccsafe.org/wp-content/uploads/2019-ICC-PUBLIC-COMMENT-AGENDA-compressed-2019-upload-upload.pdf> or here <https://www.iccsafe.org/products-and-services/i-codes/code-development-process/2019-group-b/> then "Group B Public Comment Agenda"



EU Court rejects industry appeal on endocrine disruptor

The European Court of Justice (ECJ) has rejected an action brought by Plastics Europe attempting to reverse the designation by ECHA of the plastic additive / monomer BPA (Bisphenol A) as an endocrine disrupting chemical (EDC), requiring Plastics Europe to pay the costs of ECHA and of the NGO ClientEarth. This is the second time that ECJ has rejected an appeal against the inclusion by ECHA of BPA in the Candidate List of Substances of Very High Concern (SVHC), with a third appeal (on environmental impact) expect to be heard soon. The detailed (224 point) ECJ judgement upholds ECHA's legal assessment of the substance, and discusses the meaning and interpretation of terms such as scientific evidence, inconsistencies, risk, probable effects and plausible link, endocrine disruptor, mode of action vs. mechanism of action, safe level of concentration, proportionality, legal certainty. This may prove relevant jurisprudence for future designations of chemicals to the SVHC Candidate List (see list of flame retardants currently on this list above).

European Court of Justice, General Court, 5th Chamber, 20th September 2019, Case T636/17, "REACH — Establishment of a list of substances identified with a view to their eventual inclusion in Annex XIV of Regulation (EC) No 1907/2006 — Supplement to the entry relating to the substance bisphenol A on that list — Articles 57 and 59 of Regulation No 1907/2006 — Manifest error of assessment — Legal certainty — Legitimate expectations — Proportionality"
<http://curia.europa.eu/juris/document/document.jsf?docid=217994&mode=req&pageIndex=1&dir=&occ=first&part=1&text=&doclang=EN&cid=7994>

COMMUNICATIONS

Round table meeting in October 2018

Do you think that the tax has been designed so that it will stimulate producers to select safer chemicals?



Video - Swedish FR chemical tax meeting

A five minute video summarises a stakeholder meeting on the Swedish chemicals ecotax on flame retardants, Stockholm, 17th September 2019, where Henrik Edin (IT Telekomföretagen) and Hans Wendschlag (Hewlett Packard) presented the case for a revision of the tax. This tax, introduced in 2017, hits all electrical and electronic equipment sold to the public in shops in Sweden (but not over internet from abroad), and can reach up to around 40€ per item. However, it is widely criticised because the current criteria do not stimulate safer chemical substitution, because they target the wrong chemical properties by targeting not only halogenated FRs but also all additive phosphorus FRs. There are no standard test methods to identify the chemical groups defining the tax levels, leading to legal uncertainty. The Swedish chemicals agency KEMI has already recommended that the tax should target inherent individual substance properties, with identified testing methods, and that e-commerce must not be excluded. Pinfa recommends to revise the tax, with the support of an expert group, to review the scope of which flame retardants are targeted, and to include a zero tax rate to ensure an effective push to safer chemical substitution.

"The Swedish chemical tax. Do it again and do it right". 5 minute video
http://www.beard.de/2019-04_pinfa10/2019-09-17_Swedish_Electronics_Tax.MOV



pinfa brings stakeholders to meet firefighters and fire

pinfa's Advisory Board regularly brings together interested stakeholders (GOs, regulators, fire experts, professionals ...) to discuss issues around fire safety and flame retardants, in an open but non-public dialogue. In June 2019, an exceptional meeting of the pinfa Advisory Board visited the PIVO Vlaams Brabant (public institute) fire research centre, to see, hear feel and smell small, medium and full scale (room and building) fire tests with scientists and firefighters. Participants saw how different materials can emit highly varying levels of smoke and heat, depending strongly on ventilation conditions, and just how dangerous and fire can be, with heat, unpredictability and smoke. pinfa is committed to develop and promote flame retardants which can reduce the dangers of fire, from ignition to flashover, with improved environment and health profiles.

"From ignition to flashover", pinfa Advisory Board 12th June 2019. With thanks to PIVO Vlaams Brabant, Pieter Maes (overall organisation of fire tests and demonstrations), Steve de Blauwe (presentation of fire fundamentals), German Berckmans and Kurt D'Heft (fire tests). 3 minute video Youtube: https://youtu.be/xGIV_CBR6BM

Modern Buildings Alliance "Fire Safety Guide"

The alliance of trade associations and companies representing the plastics industry in the construction sector, Modern Buildings Alliance, has published a 20 page brochure titled "EU Fire Safety Guide". The brochure targets policy makers and presents a holistic approach of how fire safety in buildings can be improved, and what actions are needed at the EU level. It is underlined that some 5 000 people per year die in buildings fires in Europe, mainly in home fires, and that most residential fires are preventable. Seven layers of building fire safety are presented: prevention, detection, early suppression, evacuation, compartmentation, structural safety and firefighting. Proposed EU actions include improved fire statistics, improving fire standards for specific products, increasing smoke alarm and automatic sprinkler installation, developing EU regulation on evacuation and safety signs, reinforcing EU product and materials safety standards and improving European exchange on best practices, for example by establishing an EU forum of experts to analyse fire causes and propose fire safety strategies (developing on the existing EU Fire Information Exchange Platform).

Modern Buildings Alliance "EU Fire Safety Guide. The 7 layers of fire safety in buildings" 2019 <https://www.modernbuildingalliance.eu/new-EU-fire-safety-guide>



Airbnb promotes fire safety in the UK

Working with the UK National Fire Chiefs Council (NFCC), Airbnb has produce a two page [guide](#) sent to over 100 000 hosts across Britain. The guide refers to the UK Governments [document](#) for [hosts](#) taking paying guests and emphasises the importance of smoke alarms and carbon monoxide alarms (both of which are offered free by Airbnb to hosts worldwide), annual verification of gas installations, prevention especially related to electrical items, closing doors at night and having an escape plan given to guests for each room.

"Airbnb Commits to Putting Fire Safety First with National Fire Chiefs Council", 32 July 2018 <https://press.airbnb.com/en-uk/airbnb-commits-to-putting-fire-safety-first-with-national-fire-chiefs-council/>





US NTSB presses for better road vehicle fire safety

The US National Transport Safety Board has reiterated its recommendation to revise the Federal Motor Vehicle Safety Standard FMVSS 302 to require more rigorous materials flammability and smoke emission requirements. The NTSB proposes to align road vehicles standards with standards for aviation and railways. This new statement follows investigation of a 2017 Oakland Iowa school bus fire in which the driver and the only passenger died. The NTSB Chairman is quoted: "Fire suppression systems, fire-resistant interior materials and improved fire safety performance standards could have provided more time for the driver and the student in this tragedy."

"Investigators say a fatal Iowa school bus fire was preventable; here's how Iowa may improve bus safety", Des Moines Register, 20th June 2019

<https://eu.desmoinesregister.com/story/news/2019/06/20/iowa-education-school-bus-fire-safety-children-students-fatal-standards-evolving-ntsb/1503481001/>

"School Bus Run-Off-Road and Fire, Oakland, Iowa, December 12, 2017", NTSB report HWY18MH003, 18th June 2019 HWY18MH003

<https://www.nts.gov/news/events/Documents/2019-HWY18MH003-BMG-abstract.pdf>



Fire code failures cost developer \$ 10M

US\$ 10 million damages and costs were awarded in 2017 to purchasers of residential property in the Grandview Riverwalk, Port Imperial development, New York State. A court has now decided that this must be paid entirely by the developer, a subsidiary of Hovnanian Enterprises, not by the architects RTKL. The construction was approved by the town as "Type B" meaning flame retardant wood should be used, but ended up including untreated plywood. Modifications proposed by the architects were apparently never approved by the town and possibly were not implemented. The developer ends up paying the damages, despite the judge indicating (according to specialist media) that the architects were also negligent.

"Hovnanian's Indemnity Action Against Architect Fails in \$10M Hudson County Condo Case", New Jersey Law Journal, 14th August 2019

<https://www.law.com/njlawjournal/2019/08/14/hovnanians-indemnity-action-against-architect-fails-in-10m-hudson-county-condo-case/?slreturn=20190824025957>



FRETWORK textile FR code of practice moves forward

The Flame Retarded Textiles Network, UK (FRETWORK) has launched a Primary Authority partnership with Nottingham County Council Trading Standards to enable participating companies to benefit from formally assured advice. FRETWORK members have developed a Code of Good Practice (FCoGP), see pinfa Newsletter n°86, for flame retardant application to furniture textiles, covering treatments made and process control, testing, compliance with the UK Furniture Fire Safety Regulations, and ensuring supply chain traceability. An audit scheme of FCoGP code compliance is now being developed with the County Trading Standards.

"Fretwork forms new Nottinghamshire council partnership" 2 September 2019 <https://cabinet-maker.co.uk/fretwork-forms-new-nottinghamshire-council-partnership/> and <https://fretwork.org.uk>



Delhi action on school fire safety

The Delhi city area government, India, has issued a notice to 241 schools for failing fire safety regulations. The action follows a Right to Information query from the Delhi Parents Association which showed that over 30% of Delhi's 7 000 plus schools did not have valid fire safety certificates. It also follows that Surat coaching centre fire in May this year, in which 22 young people died (pinfa Newsletter n°103). Fire safety failures identified in the 241 targeted schools include inadequate fire-fighting arrangements, out-of-date fire extinguishers, too narrow staircases, insufficient escape doors to classrooms, lack of water reservoirs.

<https://www.hindustantimes.com/education/ambekar-university-student-union-polls-on-september-25/story-IC7POIk21ghLmprFdkrzEP.html>



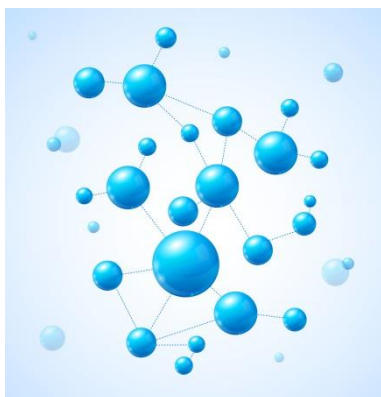
Fire fighters call Amazon to stop selling unlisted alarms

National fire service leaders and other stakeholders are supporting a "Vision 20/20" project call to ask Amazon and other e-commerce companies to stop selling unlisted smoke and carbon dioxide alarms. Some 25 models are cited which have not been tested by recognised testing laboratories, despite in some cases claiming that they are certified. Other organisations and individuals are invited to join and support this call.

"Smoke and carbon monoxide alarms being sold on e-commerce sites do not meet current product safety standards", Vision 20/20, 24th September 2019

<https://community.nfpa.org/thread/42502>

RESEARCH

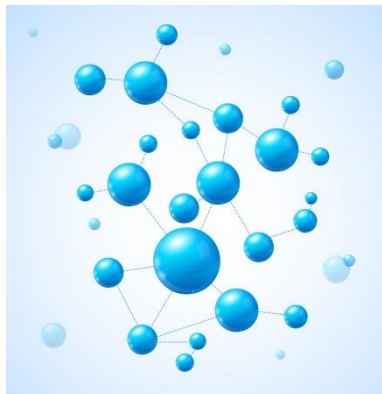


New water soluble phosphazene for textiles

Poly- and cyclo- phosphazenes are recognised effective PIN flame retardants, but to date are not available as water soluble and permanent systems for textiles. Here a new cyclophosphazene was synthesised in a one-step process: hexa (allylamine) cyclotriphosphazene (CPZ). This was stable under acidic conditions and so could be applied to textiles in aquatic solutions. Soaking was followed by photo-induced grafting (UV cross-linking). CPZ was tested for PET, PA (polyamine 6.6), cotton and blends. A 10% loading of CPZ showed durability in washing, increased LOI (limiting oxygen index) and enabled to pass DIN 75,200 (automobile) and DIN 15,025 (PSA protective clothing) with cotton and with PA- and PET-cotton blends (not with PET or PA only). The treated textiles did not pass DIN 4102-1-B2 (construction). All fire tests were carried out after at least one wash cycle. The CPZ showed to effectively generate char (except with PET only) with formation of glassy phosphoroxinitrids. Further work is underway to compare the flame retardancy mechanism of different poly- and cyclo- phosphazenes.

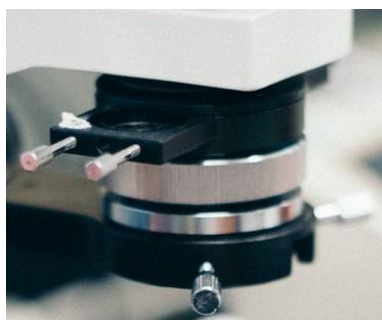
"A Green Water-Soluble Cyclophosphazene as a Flame Retardant Finish for Textiles", T. Mayer-Gall et al., Molecules 2019, 24, 3100; <https://doi.org/10.3390/molecules24173100>

Systemic analysis of P-N flame retardant design



Four comparable phosphorus-containing compounds were synthesised, each with one central P atom and three hexenyl groups: an amide (P bonded to 3xN), a diamidate (P bonded to 2xN, 1xO), an amidate (P bonded to 1xN, 2xO) and a phosphate (P bonded to 3xO). These were tested for thermal stability and as FRs at 10% loading in an epoxy resin (DGEBA/DMC). The FR performance at 10% achieved only UL94-HB (4 mm) but were comparable to BDP at the same loading. The results demonstrated different mechanisms: the phosphate (P-O bonds) showed more gas phase action, whereas the amide (C-N bonds) showed more condensed action, and optimal FR performance resulted from combinations of these. pinfa comment: further work would be useful, in that only 4 molecules of similar structure is a small sample on which to base general conclusions, and it would also be important to study the potential toxicity / ecotoxicity of the different P-N structures.

“Systematically Controlled Decomposition Mechanism in Phosphorus Flame Retardants by Precise Molecular Architecture: P-O vs P-N”, J. Markwart et al., *ACS Appl. Polym. Mater.* 2019, 1, 1118–1128 <http://dx.doi.org/10.1021/acsapm.9b00129>

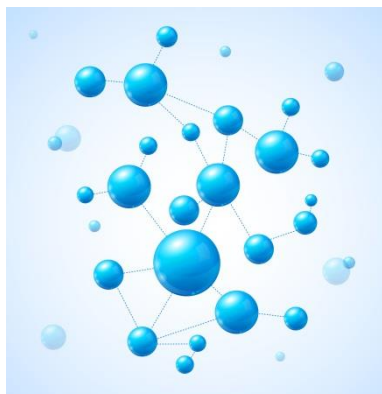


Ferrocene polymer synergist for APP

A polymer (poly((3,3'-diphenyl diacetylenediamino)-1,1'-ferrocene) = PDPFDE) was synthesised linking ferrocene, aromatic carbon rings and the nitrogen compound ethylenediamine. It is known that the iron-containing organic compound, ferrocene (cyclopentadienyl ring) can improve fire safety by smoke suppression and char formation. The ferrocene polymer here developed is shown to self-char (carbon source) and to reduce smoke. The nitrogen links are flexible, giving a plasticiser effect, as well as releasing nitrogen gases in fire. In a 2019 paper, the PDPFDE polymer was tested with APP / PER (ammonium polyphosphate / pentaerythritol) intumescent PIN FR in polypropylene. Results show that 0.5 – 1 % ferrocene polymer increased LOI and reduced heat release rate beyond that achieved with APP/PER alone, improved char structure and enabled UL94-V0 (4 mm) whereas APP/PER alone only achieved UL94-V1. Higher loads of the ferrocene polymer reduced performance, probably by catalysis of polypropylene degradation in fire. The ferrocene polymer also improved the polypropylene mechanical properties (impact strength, elongation at break). In a previous paper (2017), PDPFDE was tested at 5% loading in DGBDA/m-PDA epoxy at 5% achieved UL94-V1 (3.2 mm) and reduced peak heat release rate by 36% and total smoke production by 24% compared to neat epoxy.

“Synergistic improvement of fire retardancy and mechanical properties of ferrocene-based polymer in intumescent polypropylene composite”, W-X. Li et al., *Polym Adv Technol.* 2019, 1–12, <https://doi.org/10.1002/pat.4687>

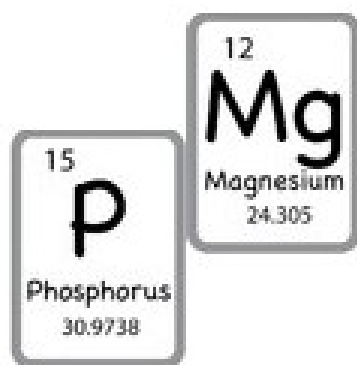
“Ferrocene-based non-phosphorus copolymer: synthesis, high-charring mechanism and its application in fire retardant epoxy resin”, D Liao et al., *Ind Eng Chem Res.* 2017, 56(44): 12630–12643, <https://doi.org/10.1021/acs.iecr.7b02980>



Melamine – bio-sourced phytate FR for polypropylene

Melamine and phytic acid (a molecule naturally found in plants) were reacted in aqueous solutions. The six phosphates in phytic acid reacted with six melamines, and two-dimensional nanoflakes were formed in drying (MEL-PA). This product was then tested at 1 – 3 % loadings in polypropylene (PP). Dispersion is shown to be good. 2% MEL-PA reduced peak heat release from 756 to 608 kW/m² and also significantly reduced smoke release rate. The flame retardancy effect is considered to result from a physical barrier role of the D2-nanoflakes, char generation (phosphorus) and dilution of oxygen (release of water and ammonia).

“Facile preparation of layered melamine-phytate flame retardant via supramolecular self-assembly technology”, S. Shang et al., Journal of Colloid and Interface Science 2019 <https://doi.org/10.1016/j.jcis.2019.06.015>



P-ester / magnesium synergy for wood FR

Cyclic phosphate ester was reacted with magnesium hydroxide (1 – 6 %) and then tested with melamine formaldehyde and pentaerythritol (at ratios 1:1 to 1:4) as a flame retardant coating on 4 mm plywood (250 g/m² coating). The magnesium containing coating achieved flame spread rating, total heat release and total smoke release respectively 34%, 29% and 55% lower than a cyclic phosphate ester only coating. Analysis shows that the presence of magnesium increases char production and improves char structure, with more phosphorus-rich cross-linked and aromatic structures in the char.

“Synthesis and application of novel magnesium phosphate ester flame retardants for transparent intumescent fire-retardant coatings applied on wood substrates”, L. Yan, Progress in Organic Coatings 129 (2019) 327–337, <https://doi.org/10.1016/j.porgcoat.2019.01.013>



Silica aerogel as FR and smoke suppressant

Polyurethane insulation foam (PUF) was surface treated with silica (SiO₂), by acid and alkali hydrolysis, then lyophilised to generate a silica aerogel at 13 – 33% w/w loading on the foam. The nano-porous structure of the aerogel resulted in improved thermal insulating performance of the PUF, improved resistance to compression and fire performance: self-extinguishing in vertical burn test, peak heat release rate reduced by over 40%. Peak smoke release and smoke optical density were reduced by 46% and 56%. The authors consider that this was because the silica aerogel increased the melt viscosity of the polyurethane in fire and generated a compact silica-rich char.

“Hierarchically porous SiO₂/polyurethane foam composites towards excellent thermal insulating, flame-retardant and smoke-suppressant performances”, M-E. Li et al., Journal of Hazardous Materials 375 (2019) 61–69, <https://doi.org/10.1016/j.jhazmat.2019.04.065>

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