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SAFE & SUSTAINABLE FLAME RETARDANTS



pinfa webinar, 27, 28 and 30 June 2022, 16h – 17h CEST “What are Safe and Sustainable Flame Retardants?” with Schneider Electric, ChemForward, TCO Development, ChemSec, Cefic. Do consumers and downstream users expect fire safety to equal safety for the environment and human health? Can durability be considered a benefit if it also implies persistence? What implications are there if a grouping approach for flame retardants is applied?

Registration: www.pinfa.eu or pinfa@cefic.be

PUBLIC CONSULTATIONS

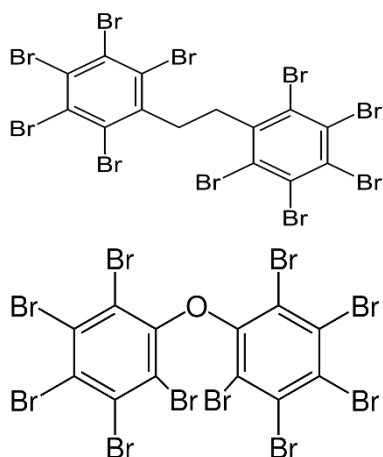


EU CPR text consultation

Proposed regulatory text for update of Construction Products Regulation. Prolonged to 12th July. This new Regulation text is likely to considerably modify conditions for validation of CE-marks and so EU market access, impacting fire safety of construction products. The public consultation is on the proposed new CPR Regulation text, before it goes to discussion in the European Parliament and Council. The public, including organisations and companies, can make input with a short statement (4000 characters) plus a document. pinfa will publish our submission on the [pinfa website](http://www.pinfa.eu) early July.

“Construction products – review of EU rules”. Any member of the public, company or organisation can input a 4000 character comment and/or a position or proposal document (max. 5 Mo).

https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12458-Construction-products-review-of-EU-rules_en



Above: DBDPE
Below: DecaBDE
Diagrams from Wikipedia

Canada consults to ban DBDPE and DP

To 28th July 2022: proposed bans of decabromodiphenyl ethane (DBDPE) and Dechlorane Plus (DP), as well as on extension of existing bans on brominated FRs HBCD and PBDEs.

Note: decabromodiphenyl ethane (DBDPE, ENIECS 262-680-7) is a different chemical from DecaBDE, which is a PBDE (polybrominated diphenylethers), and is already banned in Canada (see below), but its chemical structure is similar (see images left from Wikipedia).

The risk assessments of DBDPE and DP concluded that they are persistent and widespread in Canada's environment, and that DBDPE, DP and breakdown products of PBDBE are potentially toxic. The proposal will add these two halogenated flame retardants to the Canada CEPA Schedule 1 list of Toxic Substances. The proposal would (after six months) prohibit the manufacture, use, sale and import of DBDPE and of Dechlorane Plus in Canada. For a three-year transitional period, exemptions could be authorised by permit in cases where no technically or economically feasible alternatives are available. Exemptions proposed are imports of compounds containing DBDPE for wire and cable manufacture for 5 years, vehicle and specific parts for 5 years, replacement parts for 20 years.

Dechlorane Plus is already under consideration by the Stockholm Convention for possible designation as a "POP", which would lead to a global ban, whereas this proposed regulation would be the first national ban on PBDBE worldwide.

For PBDEs, the proposals would reduce exemptions in the existing ban, to result in a complete ban except for vehicle parts to 2036 and certain existing or in-transit pellets (simplified). For HBCD, the changes would extend the existing ban on the substance HBCD and on extruded polystyrene containing HBCD, to result in a ban all articles containing HBCD, with limited exemptions for vehicle parts to 2035 and for existing articles.

"Prohibition of Certain Toxic Substances Regulations, 2022 [Proposed]", Canada Government [HERE](#) and Canada Gazette Part I, Vol. 156, No. 20, 14th April 2022 .

"Share your thoughts: Proposed Prohibition of Certain Toxic Substances Regulations, 2022", Comments deadline 28th July 2022

<https://www.canada.ca/en/environment-climate-change/corporate/transparency/consultations/consultation-proposed-prohibition-regulations.html>

CHEMICALS POLICY AND CHEMICAL SAFETY



EU “chemicals restrictions roadmap”

The European Commission has published a “roadmap” of assessment priorities for chemicals for possible restrictions. The Commission states that the roadmap “prioritises group restrictions for the most harmful substances to human health and the environment” as set out in the Green Deal Chemicals Strategy for Sustainability, and will become the basis for multiannual planning under REACH, to be regularly reviewed to ensure flexibility and progress. The Commission cites the Council (Member States) [position](#) for “prioritisation of restrictions for the most harmful chemicals to be covered by the generic approach for all uses and through grouping as an interim solution until the extension of the generic approach to risk management is fully implemented”.

Chemicals proposed for possible restriction are listed under three “pools”. Pools 0 and 2 are chemicals for which restrictions are already proposed or considered. Pool 1 is chemicals under consideration by the Commission, ECHA or Member States but not yet on the Community Rolling Action Plan (CoRAP).

The following chemicals relevant to flame retardants are included in the roadmap:

- Pool1:
 - Commission Request n°3: “Organophosphate flame retardants (OPFRs) TCEP, TCPP, TDCP”. *
 - Commission Request n°8: Flame retardants – group. “ECHA will prepare an overall strategy on flame retardants by 2022, ... The substances in scope are in principle all flame retardants, and there will be particular focus on brominated flame retardants and their prioritisation for restrictions. ...”
 - Potential restrictions under discussion n°4: Borates – group.
 - Groups where CLH or candidate listing to be carried out with restriction as suggested risk management n°2: Simple manganese compounds and n°4: Acrylates and methacrylates
- Pool 0 and pool 2:
 - ECHA/Commission request:
 - Medium chain chlorinated paraffins (MCPs)
 - Member States:
 - Dechlorane Plus
- Annex II - Overview of Article 69(2) assessments: HBCDD, TCEP, trixylyl phosphates, sodium perborate - perboric acid sodium salt.

Cefic’s Statement on the Restrictions Roadmap calls for a clear implementation process which takes into account impacts on the value chain, and for sufficient resourcing and expertise to be ensured within regulators, in particular ECHA.

* TCEP = tris(2-chloroethyl) phosphate, TCPP = tris(2-chloro-1-methylethyl) phosphate, TDCP = (TCPP), tris[2-chloro-1-(chloromethyl)ethyl] phosphate.

“Sustainable Chemicals: The Commission advances work on restrictions of harmful chemical substances”, European Commission 25th April 2022 https://ec.europa.eu/growth/news/sustainable-chemicals-commission-advances-work-restrictions-harmful-chemical-substances-2022-04-25_en

SWD 2022 128 (25th April 2022) “Commission working document. Restrictions Roadmap under the Chemicals Strategy for Sustainability” <https://ec.europa.eu/growth/news/sustainable-chemicals-commission-advances-work-restrictions-harmful-chemical-substances-2022-04-25>

“Cefic Statement on the Restrictions Roadmap”, 25th April 2022 <https://cefic.org/media-corner/newsroom/cefic-statement-on-the-restrictions-roadmap/>



EU biomonitoring conclusions on FRs

HBM4EU conference says data is inadequate for 60+ current use FRs, suggests potential endocrine disrupting concerns.

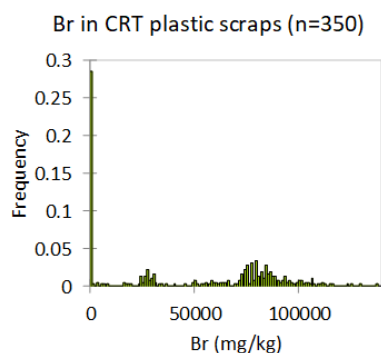
The EU-funded HBM4EU human biomonitoring project (Horizon2020) is coordinated by the German Environment Agency UBA and involves several European Agencies (EEA, EFSA, ECHA), WHO and governments of 30 countries. At the project final conference, (27-28 April 2022), Lisa Melymuk, Masaryk University (Czech Republic) presented the project conclusions on flame retardants. The project considered “legacy” brominated FRs (PBDEs, HBCDDs: now restricted, but continuing to be found in products, humans, the environment), 35 currently used halogenated FRs (brominated, chlorinated) and 14 current non-halogenated FRs (including phosphorus and nitrogen based FRs). Conclusions presented suggest a possible link between legacy brominated FRs PBDEs and ADHD (Attention Deficit Hyperactivity Disorder) and evidence of endocrine disrupting activity (ED) for current use FRs, both halogenated FRs (TDCIPP, TBBPA) and non-halogenated phosphate esters (TPhP, TMPP). Several other FRs may have potential for ED, but the evidence is inconclusive (see [Bajard et al., 2021](#), summarised in pinfa Newsletter n°125). Similarities in FR (anti-androgenic) ED profiles suggest that presence of multiple FRs in products, air, dust and diet may lead to ED effects due to the cumulative effect of low level exposures to multiple FRs. It is stated that for current use FRs, overall, toxicological data is limited, epidemiological data very limited, and data on human exposure via food is limited. In particular, for current use FRs, data on possible ED effects (in vivo, mechanistic, in vitro ED activity data) is considered inadequate.

"Flame retardants from Europe. Results and policy implications", L. Melymuk, HBM4EU final conference, 27-28 April 2022

<https://www.hbm4eu.eu/result/hbm4eu-final-conference/>

HBM4EU video on Flame Retardants (2 ½ minutes)

<https://www.youtube.com/watch?v=wW12ZNY5bU>



Flame retardants, Classification, recycling

Analysis of 69 FRs suggests that 12 (7 halogenated/ATO, 5 PIN) may lead to Classification of plastic wastes, so posing a regulatory obstacle to recycling. In total, 23 out of 69 FRs are identified as potentially posing regulatory obstacles to recycling: 16 halogenated (2 no longer used, 7 Classified, 7 under ECHA evaluation) and 7 PIN (5 Classified, 2 under ECHA evaluation).

Data on flame retardant use, including concentrations susceptible to be used in plastics, and Hazard Classification statements, were collated from the Plastics Additives Initiative (PAI), ECHA, the pinfa website and FR manufacturers catalogues. A list of 69 flame retardants used in the EU was established from these sources and, within this list, twelve FRs were identified as susceptible to be present in plastics at concentrations leading to Classification of end-of-life plastics as Hazardous waste.

Sorting and management options for plastics containing these FRs are discussed, concluding that the concentration limit for sorting of 0.2% bromine should be maintained because this includes all the brominated flame retardants currently under reassessment by ECHA.

Seven of the twelve currently-used FRs identified as susceptible to lead to Hazardous Classification of plastic wastes are halogenated FRs and their synergists:

- [not counted – banned] HBCDD, EINECS 221-695-9 = Hexabromocyclododecane (POP and other)
- [not counted – banned] DecaBDE, EINECS 214-604-9 = Bis(pentabromophenyl) ether (POP and other)
- TBBPA, EINECS 201-236-9 = 2,2',6'-tetrabromo-4,4'-isopropylidenediphenol (H410)
- DBNPG, EINECS 221-967-7 = Dibromoneopentyl glycol = 2,2-Bis(bromomethyl)-1,3-propanediol = 2,2-bis(bromomethyl)propane-1,3-diol
- TBNPA, EINECS 253-057-0 = Tribromoneopentyl alcohol
- TBP, EINECS 204-278-6 = 2,4,6-tribromophenol
- TDCP, EINECS 237-159-2 = Tris[2-chloro-1-(chloromethyl)ethyl] phosphate (H351, H411)
- MCCP = Alkanes, C14-17, chloro (PBT, H400, H410, H362)
- ATO = Diantimony Trioxide (H351)

Five are non-halogenated FRs:

- Reaction mass of p-t-butylphenyl diphenyl phosphate and bis(p-t-butylphenyl) phenyl phosphate and triphenyl phosphate (H410, H411), EINECS 700-9990-0
- PIP = TrTPP, EINECS 273-066-3 = Phenol, isopropylated, phosphate (3:1) (H361, H410, H411)
- Dimethyl propylphosphonate (H360), EINECS 242-555-3
- Melamine = 1,3,5-triazine-2,4,6-triamine (H361)
- Melamine cyanurate = 1,3,5-triazine-2,4,6(1H,3H,5H)-trione, compound with 1,3,5-triazine-2,4,6-triamine (1:1) (H373)

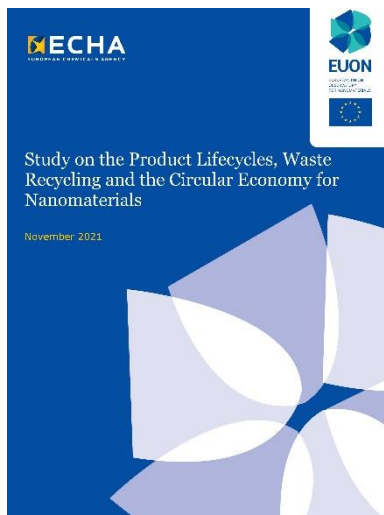
In addition to the above, it is noted that ECHA re-assessment is underway for 12 FRs, of which 4 are already listed above (TBBPA, DBNPG, PIP, TDCP) plus an additional 6 halogenated and 2 non-halogenated FRs:

- 2,4,6-tris(2,4,6-tribromophenoxy)-1,3,5-triazine (PBT), EINECS 426-040-2
- DBDPE, EINECS 262-680-7 = Decabromodiphenyldioxyethane = 1,1'-(ethane-1,2-diyl)bis[pentabromobenzene] (PBT),
- EBTBP, EINECS 251-118-6 = Ethylene-bistetra bromophthalimide = N,N'-ethylenebis(3,4,5,6-tetra bromophthalimide) (PBT)
- FR720, EINECS 244-617-5 = Tetra bromobisphenol A, bis (2,3-dibromopropyl ether) = 1,1'-(isopropylidene)bis[3,5-dibromo-4-(2,3-dibromopropoxy)benzene] (PBT, ED)
- 1,1'-(isopropylidene)bis[3,5-dibromo-4-(2,3-dibromo-2-methylpropoxy)benzene] (ED), EINECS 306-832-3
- Dechlorane plus, EINECS 236-948-9 = Dodecachlorodimethan-o-dibenzocyclooctane (PBT, POP)
- EINECS 252-813-7 = 6H-dibenz[c,e][1,2]oxaphosphorin 6-oxide (SS = skin sensitising)
- TEP, EINECS 201-114-5 = Triethyl phosphate (H302)

Graphic: Distribution of total bromine in the dense fraction of plastic scraps of screens, mainly cathode ray tubes (CRT) (from Hennebert 2019, [Proceedings of the 17th International Waste Management and Landfill Symposium \(Sardinia 2019\)](#), 30/09 – 04/10/2019, Cagliari, Italy – with permission).

*“Hazardous properties of brominated, phosphorus, chlorinated, nitrogen and mineal flame retardants in plastics which may hinder their recycling”, P. Hennebert, *Detritus*, Volume 17, December 2021, pages 49-57*
<https://doi.org/10.31025/2611-4135/2021.15142>

*“The substitution of regulated brominated flame retardants in plastic products and waste and the declared properties of the substitutes in REACH”, P. Hennebert, *Detritus*, Volume 16, 2021, pages 16-25*
<https://doi.org/10.31025/2611-4135/2021.15122>



ECHA report on nanomaterials End-of-Life

EU report calling for research on recycling and environmental impacts of nano-materials is relevant for PIN FRs. The 130-page report from ECHA (European Chemicals Agency) and EUON (European Union Observatory for Nanomaterials) states that nano-fillers have “potential to contribute to increasing recycling rates of waste and the quality of the recycled products” but on the other hand it is indicated “the environmental and human health impact of nanoparticles has not yet been fully investigated; reports about the recyclability of nano-enhanced secondary products and materials are absent”. The report notes a lack of data concerning the “toxicity of incineration residues from the combustion of waste containing nanomaterials”, but refers to three studies based on in-vitro cell tests (summarised below). The report’s recommendations include: developing public datasets of presence of nano-materials in products; field research on exposure to nano-materials in waste management and recycling; improving scientific evidence on the relationship between in vitro data and real risk associated with exposure.

- Chivas-Joly 2019: tested cytotoxicity of soot (particulate matter in gas) and residual ash from incineration of EVA containing 5 wt% aluminium PIN nano-fillers (alumina, boehmite). The residual ash was not cytotoxic, whereas soots from nano-filled EVAs were cytotoxic, and the cytotoxicity of boehmite-EVA soot was higher than that of pristine boehmite.
- Vejerano 2015: tested oxidative potential, cytotoxicity and genotoxicity of particles resulting from incineration of pure nano-materials and of paper and plastics containing them at 0.1 – 10 wt% (inc. silver, nickel, titanium cerium, carbon C₆₀, iron and other metals). Most of the nanomaterials ended up in bottom ash: mostly < 1% in particulate matter (soot), except for C₆₀ (one quarter in soot). Silver, titanium and C₆₀ nano-particles showed oxidative potential in soot, whereas iron, nickel and cerium did not. None of the nanofillers significantly modified cytotoxicity or genotoxicity of the soot.
- Stueckle 2019: one nano-clay (bentonite) and three surface-modified clays (smectite clays with organic coatings) were tested for toxic effects on lung cells, pristine and ash after combustion at 550 – 900 °C. Results show that the combustion modifies the cell toxicity of the nano-clays.

Other studies not cited in the ECHA – EUON report address the release of nano-materials, not used as flame retardants, from polymer composites. Kotsilkov 2018 tested graphene and carbon nanotubes @ 3 wt% in PLA films, showing that these are largely eliminated in incineration at 850°C but may be found in ash in combustion at lower temperatures. Greiner 2021 (see pinfa Newsletter n°123) showed that phosphorus PIN flame retardants can reduce emissions of respirable carbon fibre particles from composites in fires (see also Laura Greiner in pinfa Newsletter n°105).

“Study on the Product Lifecycles, Waste Recycling and the Circular Economy for Nanomaterials”, RPA for European Union Observatory for Nanomaterials (EUON), Reference: ECHA-22-R-11-EN, ISBN: 978-92-9468-014-3, November 2021 https://euon.echa.europa.eu/documents/2435000/3268576/nano_lifecycles_euon_en.pdf/

“Physical, morphological and chemical modification of Al-based nanofillers in by-products of incinerated nanocomposites and related biological outcome”, C. Chivas-Joly et al. *J. Hazardous Materials, Elsevier, 2019*, 365, pp.405-412 <https://doi.org/10.1016/j.jhazmat.2018.10.029>

“Toxicity of particulate matter from incineration of nanowaste”, E. Vejerano et al., *Environ. Sci. Nano, 2015*, 2, 143–154 <https://doi.org/10.1039/C4EN00182F>

“Impacts of Organomodified Nanoclays and Their Incinerated Byproducts on Bronchial Cell Monolayer Integrity”, T. Stueckle et al., *Chem Res Toxicol. 2019 December* 16; 32(12): 2445–2458 <https://doi.org/10.1021/acs.chemrestox.9b00277>

“Prevention of the formation of respirable fibers in carbon fiber reinforced epoxy resins during combustion by phosphorus or silicon containing flame retardants”, L. Greiner et al., *Polymer Degradation and Stability* 185 (2021) 109497 <https://doi.org/10.1016/j.polymdegradstab.2021.109497>



China announces tighter chemical safety

New Pollutants Control Action Plan will drive chemical data, assessment and regulation over the coming three years. The new Government Plan, published May 2022, will go considerably further than the current lists of priority controlled chemicals published in China, which include partial or total bans on four halogenated flame retardants (HBCD, DecaBDE, SCCPs, DechloranePlus). The new Plan aims to complete national data collection on chemicals by end 2023, complete risk screening of high concern and high volume chemicals, publish a list of new pollutants subject to priority controls before end 2022, publish a dynamic inventory of new pollutants before end 2025, implement risk control measures (restrictions, emissions limits) and establish a new regulatory framework for chemicals and for environmental management of toxic and hazardous substances. The China Ministry for Ecology and Environment (MEE) has [indicated](#) four types of new pollutants of concern: POPs, endocrine disruptors, antibiotics and microplastics.

“China publishes final version of new pollutants action plan”
 ChemicalWatch 25th May 2022 <https://chemicalwatch.com/489928/china-publishes-final-version-of-new-pollutants-action-plan>

China New Pollutant Control Action Plan (MEE), in Chinese
http://www.gov.cn/zhengce/content/2022-05/24/content_5692059.htm

FIRE SAFETY



27 dead in Delhi office fire

The deadly fire in a four-storey commercial building, Mundka, Delhi, is thought to have been caused by a short-circuit. The fire 13th May 2022, indicated to have started in the offices of a CCTV camera manufacturing company, killed 27 and injured over 40. Media reports suggest that the building, in which some 70 persons were working, did not have fire safety certification, and had no fire escape door and no fire extinguishers. The fire service states that most victims died of asphyxiation.

“Delhi office fire: Dozens killed as fire sweeps through building”, BBC date 14th May 2022 <https://www.bbc.com/news/world-asia-india-61445600>

“India: 27 people killed after fire rips through Delhi office block. Dozens injured as official says building had no fire exit and most died ‘due to asphyxiation’”, The Guardian, 14th May 2022
<https://www.theguardian.com/world/2022/may/14/india-27-people-killed-after-fire-rips-through-delhi-office-block>



Scientist questions rollback of fire safety

“Flame retardant chemicals do work ... are an important part of our fire safety protection systems ” says Alexander Morgan, a global leading fire expert at University of Drayton, USA. In a 3-page, independent article (no financial support from any organisation) in the Journal of Fire Sciences, supported by nearly thirty science references, Dr. Morgan considers that “It is a blatant falsehood that flame retardants do not work, and it is something that all fire safety scientists should speak up about”. Flame retardants, he underlines, are effective in the fire scenarios for which they are designed, but cannot be effective in all situations. That is a reason to develop new FRs for new challenges (such as lithium ion batteries), not to abandon fire safety. Dr. Morgan also underlines that some flame retardants have been found to be problematic for health or the environment, but that others are known to be safe, citing the inorganic PIN FR MDH (magnesium hydroxide) which is also the active ingredient of the stomach calming tablets “Milk of Magnesia”. Fire safety should not be rolled-back “because someone does not want to use FR chemicals. It is possible to have fire safety AND environmental safety”.

“The well-meaning but misguided rollback of fire safety in the United States”, A. Morgan, J. Fire Sciences

<https://doi.org/10.1177/07349041221096609>



China further tightens battery standards

China announces update of Lithium Ion battery technology standards. This follows new standards for EVs in 2021. From 1st January 2021, three new standards are applicable in China: GB 18384-2020 Safety Requirements for Electric Vehicles (includes battery fault alarm requirements, vehicle waterproofing, battery insulation and electrical safety), GB 38032-2020 Safety Requirements for Electric Passenger Cars (collision protection of batteries in vehicles, charging systems, fire resistance requirements for high-voltage components) and GB 38031-2020 Safety Requirements for Power Storage Battery for Electric Vehicles (battery cell, module and cover safety requirements, including mechanical and fire resistance). China also has conditions applicable to companies manufacturing lithium ion batteries in China: % of turnover spent on R&D, monitoring of uniformity of electrodes in manufacturing, capacity to test battery faults and resistance after battery assembly, etc. In December 2021, China announced revision of its lithium ion battery standards, with the aim of promoting technological progress in industry.

“Strategies to meet new safety standards for electric vehicle batteries in China” 17th June 2021 <https://www.exponent.com/knowledge/thought-leadership/2021/06/safety-standards-electric-vehicle-batteries-china/>

“China issues a new industry standard for lithium-ion batteries”, 11 December 2021 <https://www.gizchina.com/2021/12/11/china-issues-a-new-industry-standard-for-lithium-ion-batteries/>

INNOVATION & RESEARCH



PIN polyphthalamides (PPA) offer high RTI

BASF's latest PIN flame retardant PPA grades provide thermal stability, high electrical insulation and low water uptake. The PIN FR polyphthalamide (PPA) range includes compounds based on PA9T, PA66/6T, PA6T/66 and PA6T/6. These offer ease of processing, electrical RTI up to 160°C. The absence of halogens to EN 50642 avoids corrosion and possible failure of electrical systems. PIN flame retardants ensure UL 94 V-0 down to 0.4 mm, as per cable management standard CMS EN 50654 (2018-5). Low water uptake and resilience of mechanical and electrical properties (dielectrical strength) at high temperatures ensure reliability with ageing and suitability for e.g. consumer electronics, transport applications, electric vehicles, miniature circuit-breakers, wire-board and board-board connectors, switch gear and sensors. BASF offer a total of over 50 compound grades of PPA for injection molding and extrusion.

"New flame-retardant polyphthalamides for stable electronic components without corrosion", BASF press release, 25th April 2022
<https://www.basf.com/global/en/media/news-releases/2022/04/p-22-210.html>

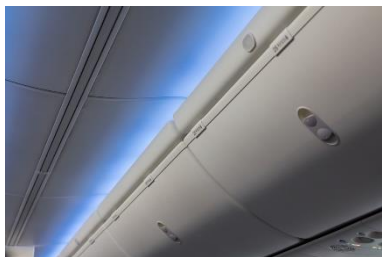


ZHF TPU for wire and cable

Lubrizol's new ESTANE® ZHF (zero halogen flame retardant) TPU offers performance, aesthetic quality and UL 105°C rating. The TPU (thermosplastic polyurethane) is DIN VDE 282 (standard for flexible insulated sleeving) uses PIN flame retardants (non-halogenated) to achieve UL 94 V-0 (2 mm) fire performance and passes Cable Flame Test UL-1581 sec. 1061 down to 8 mm cables. High mechanical properties include ultimate elongation of 460% suitable for applications including industrial and consumer electrical equipment and fibre optic cables. The ZHF resins can also be applied in robotics, data/communication cables, electric vehicle (EV) charging cables and mining and marine cables.

Image Courtesy of The Lubrizol Corporation

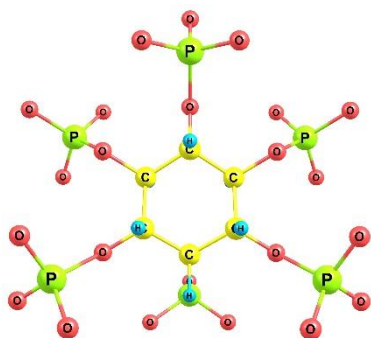
"Lubrizol Launches Unique ESTANE® ZHF TPU grade for Non-halogenated Flame Retardant Cables", 18 January 2022
<https://www.lubrizol.com/Newscenter/News-and-Insights/2022/Flame-retardant-unique-polymer-for-cables>



FR tapes & films for aviation, automobile

FLEXcon has expanded its non-halogenated, flame retardant portfolio with 2.0 and 4.0 mm transfer tapes and coated films. FLEXcon specialises in adhesive coating and laminating. The company's L-59FR Series products now achieve UL 94 V-0 at 2.0 to 4.0 mm coating thickness. FLEXcon® L-59FR Series products at 2.0 mm thickness also comply with Federal Aviation Regulation (FAR 25.853) standards for Vertical Burn (12 and 60 seconds), Heat Release, Smoke Density, and Toxicity (BSS 7239). Applications in aviation include component materials for interior ceiling and wall panels, textiles and floor coverings, seat cushions, structural flooring, and electrical conduits. FLEXmark® L-59FR coated films at 2.0 mm thickness also meet Federal Motor Vehicle Safety Standard (FMVSS) 302. Applications in automotive include components for seat cushions, sun visors, engine compartment covers, and trim panels.

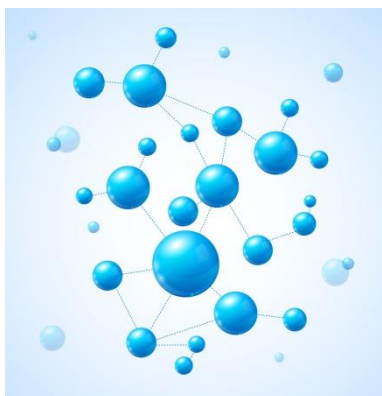
"FLEXcon Expands Product Line and Flammability Testing for L-59FR Series Flame-Retardant Adhesive", 2 March 2022
<https://www.flexcon.com/about/news-events/news-releases/flexcon-expands-product-line-and-flammability-testing>



Review of phytic acid as a PIN FR

Phytic acid from plants, which contains 28% phosphorus w/w, is increasingly tested as the basis for bio-based PIN FRs. The review summarises nearly one hundred studies of phytic acid and compounds based on phytic acid as PIN FRs in a range of polymers and applications (including EVA, PLA, PA, PU, PP, PVC, PE, epoxy). Phytic acid itself ($C_6H_{18}P_6$) has limitations as a flame retardant because it is hydrophilic and because high loadings are required. However, its six double hydroxyl (-OH) groups can be readily combined with metals giving phytate salts in which the metal ion provides flame retardant or smoke suppression synergies, including salts of Al, Cu, Fe, La, Mg, Na, Ni, W. The metal salts can improve gas phase flame quenching and contribute to compact, glossy char formation. Phytic acid can also be combined with inorganic FRs, e.g. by coating metal hydroxides onto phytate salts. Phytic acid can also be combined with nitrogen FRs, again by the hydroxyl groups, e.g. urea, melamine, diamines. Phytic acid – melamine nanosheets have shown to be effective in reducing heat release and smoke emission in PU, epoxy and PP. The nanosheets can also be doped with synergistic metal ions (e.g. Mn). Phytic acid and melamine can also be combined onto nanofillers, such as carbon nanotubes. The authors identify as areas for future research: further combinations of phytic acid with other materials to avoid hydrophilicity limitations; delivery as polyelectrolyte; combination with bio-sourced carbon materials (such as lignin); application in 3D-printing (no studies identified to date).

"Flame retardancy efficacy of phytic acid: An overview", T. Mokhena et al., J. Applied Science 2002, e52495 <https://doi.org/10.1002/app.52495>



Aluminium - phosphorus - nitrogen synergy

Trials suggest that an aluminium phosphonate and melamine cyanurate provide synergistic fire protection coating for ABS. EMPCP (ethylene glycol methyl propionate cyclohexanediol phosphonate) was reacted with aluminium isopropoxide to general an aluminium phosphonate (EMPCP-Al). This was tested with polyvinyl formal (PVFO) and melamine cyanurate (MCA), at ratio 88:9:3, as a surface coating for ABS polymer, coating thickness 50 – 130 µm (after 1 – 5 coatings by solvent deposition and evaporation) on 3.5 mm thick ABS samples. Limiting oxygen index (LOI) was increased from 17 (non-coated ABS) to 29 %, and peak heat release rate was reduced by over 50%, achieving UL 94 V-0. Analysis showed that the coating increased carbon dioxide and water release, and decreased hydrocarbon gas release. The authors conclude that this PIN coating achieves fire performance for ABS without modifying mechanical properties.

“Highly efficient intumescent flame retardant coating for ABS: Preparation and application”, J. Chen et al., J Appl Polym Sci. 2022, 139, e51860, <https://doi.org/10.1002/app.51860>



PIN FRs effects on PU foam smoke

PIN flame retardants show varying impacts on fire performance and smoke emissions from rigid polyurethane foam. Seven combinations of P-based, inorganic and nitrogen flame retardants and nano-fillers were tested and compared to pure rigid PU foam: triethylphosphate (TEP), dimethylpropanphosphonate (DMPP), cyclic phosphorus compound, aluminum hydroxide (ATH), ammonium polyphosphate (APP), zinc borate, multi-walled carbon nanotubes (MWNTs) and nanosized titanium dioxide. One combination showed negative effects both on fire performance (peak heat release rate pHRR, MARHE) and on smoke emission. The other six PIN combinations reduced pHRR and MARHE. A combination of 11% total loading of the three phosphorus PIN FRs, 15% zinc borate and 3% carbon nanotubes achieved nearly -20% pHRR and improvement of all four measured smoke parameters (-10% total smoke release, -13% maximum smoke density). Volatile organics in fire gases were analysed, concluding that nano-fillers reduced the amount and number of occurring products, but nano-particles were not analysed in fire gases.

“Analysis of flammability and smoke emission of rigid polyurethane foams modified with nanoparticles and halogen-free fire retardants”, K. Salasinska et al., J Therm Anal Calorim (2017) 130:131–141 <https://doi.org/10.1007/s10973-017-6294-4>

OTHER NEWS



Reprotox screening of organo-phosphorus flame retardants: 46 phosphorus FRs (11 alkyl, 24 aryl, 11 chlorinated) were experimentally screened for placentation – disrupting effects, by inhibition of proliferation of human trophoblast cells. Three aryl phosphates, of the 46 tested OPFRs, showed disruption potential in the screening (EHDPP = 2-Ethylhexyl diphenyl phosphate CAS 1241-94-7, o-TCrP = Tri-O-cresyl phosphate CAS 78-30-8, B4tBPPP = Bis(p-tert-butylphenyl) phenyl phosphate CAS 115-87-7). Of these three, EHDPP was selected for further testing because it has been detected in soil, dust, water and food. In a 10-day in vitro test, EHDPP interfered with the insulin-like growth factor 1 receptor protein (IGF1R), inhibiting aerobic cell respiration and so villous cytotrophoblasts (VCT) cell proliferation. Animal tests using female mice, exposed to EHDPP at 0 – 10 mg/kg body weight/day before and during pregnancy showed placentation disorders, with related failures of pregnancy, reduced fetal growth and impaired glucose tolerance.

“Screening of Organophosphate Flame Retardants with Placentation-Disrupting Effects in Human Trophoblast Organoid Model and Characterization of Adverse Pregnancy Outcomes in Mice”, C. Xu et al., Environmental Health Perspectives 057002-1, 130(5) May 2022
<https://doi.org/10.1289/EHP10273>

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