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### Fire safety in greener electronics

SAMPE, SPE and pinfa-na are organising a two-day workshop in San José, California, 30<sup>th</sup> April – 1<sup>st</sup> May 2019, on “Design for fire safety in greener electronics”, providing information on selection of flame retardants, test methods, environmental regulation, manufacturing and materials technologies. Speakers include: IBM, Hewlett Packard, Texas Instruments as well as flame retardant and materials companies, researchers and experts.

Programme and registration: <http://www.pinfa-na.org/>



### IAFSS to propose a fire safety “Mission” to EU

The International Association for Fire Safety Science has published [conclusions](#) from the European stakeholder meeting organised on 3<sup>rd</sup> December 2018, with support from pinfa. IAFSS has agreed to “craft a Mission statement for communication with the Commission and the Fire Science Community”. The objective is to make Europe the world leader in resilience to climate-induced wildland fire and in innovation in fire-safe and sustainable materials, systems and buildings. The vision is that fire safety should “become an enabler of an envisaged future”, a “force for good” that is an integral part of societal prosperity and progress (including new products, technologies or materials). Key challenges noted are the need for agreed benchmarks and data, as well as a lack of awareness of fire safety. The idea to promote the establishment of a European Fire Safety Agency was discussed. The conclusions propose key words, actions and obstacles identified by the meeting during breakout groups, with the themes of sustainability, health, society resilience showing as shared priorities.

IAFSS European stakeholder workshop on fire safety, Brussels, 3<sup>rd</sup> December 2018 (with pinfa support) <https://iafss.org/2018/12/19/iafss-workshop-to-define-a-fire-safety-mission-for-europe/>



## Campaign on fire safety for next European Parliament

FSEU ([Fire Safe Europe](#)), and Vladimir Maňka, MEP, with over 20 other MEPs, have launched a campaign targeting current members of the European Parliament and candidates for the May 2019 European Parliament elections to “pledge to improve fire safety”. The #Together4FireSafety pledge campaign underlines that there are 5 000 fire per day in Europe, killing 11 people and hospitalising nearly 200, and that improving fire safety can avoid societal disruption (e.g. school fires disrupt education of 90 000 children per year in the UK alone), reduce negative economic impacts, and protect the environment (emissions of pollutants such as dioxins in accidental fires). Organisations and individuals are invited to support the pledge campaign [here](#).

FSEU ([Fire Safe Europe](#)) #Together4FireSafety pledge campaign launch, 20<sup>th</sup> February 2019  
<https://firesafeeurope.eu/together4firesafety/>



## EU EcoDesign criteria proposal for ‘displays’

The European Commission draft criteria for “electronic displays” under the EcoDesign [Directive](#) (2009/125/EC) excludes halogenated flame retardants from enclosures and stands (see previous information in pinfa Newsletter n°95). EU EcoDesign criteria are mandatory (whereas EcoLabel criteria are voluntary). The draft criteria, currently under final discussion in [comitology](#) state that “Presence of halogenated flame retardants represents a major issue in the recycling of plastics of electronic displays. ... Control on maximum content of non-permitted compounds in recycled plastic is not cost-effective, resulting in all being incinerated. ... Use of halogenated flame retardants in these parts should be limited”. The proposed criteria also require that, for all plastic parts > 50g containing flame retardants, the polymer(s) and the flame retardant(s) be specified: to our understanding, this means according to ISO 1043 codes, which specify 42 different families of flame retardant (see pinfa Newsletter n°95). [ECOS](#) (European Environmental Citizens Organisation for Standardisation), [EEB](#) and [CoolProducts](#) have written to the European Commission supporting this exclusion of halogenated flame retardants.

European Commission draft EcoDesign criteria for ‘electronic displays’, 19<sup>th</sup> December 2018  
[http://ec.europa.eu/transparency/regcomitology/index.cfm?do=search.documentdetail&Dos\\_ID=16995&ds\\_id=59740&version=2&page=1](http://ec.europa.eu/transparency/regcomitology/index.cfm?do=search.documentdetail&Dos_ID=16995&ds_id=59740&version=2&page=1)

“ECOS and partners welcome ban on halogenated flame retardants in electronic displays”, 11 February 2019 <http://ecostandard.org/ecos-and-partners-welcome-ban-on-halogenated-flame-retardants-in-electronic-displays/>



## ASTM draft standard on “blooming” of brominated FRs

The American Society of Testing and Materials ([ASTM](#)), which operates over 12 000 standards worldwide, has circulated for ballot a new standard method for analysis of “blooming” of brominated flame retardants on the surface of polymers. Comments will be discussed at the next ASTM D20 meeting in April 2019 in Denver.

ASTM D20 Plastics, WK65732 “New Test Method for Determination of the Blooming of Brominated Flame Retardants onto the Surface of Plastic Materials”  
<https://www.astm.org/DATABASE.CART/WORKITEMS/WK65732.htm>

As ABS pipe was demonstrated to have the highest fire risk of the materials tested, rulemaking to include fire retardant in ABS may be warranted.  
Adopt a process that evaluates all fire retardants for adverse outcomes to human health and the environment by a suitable agency such as the EPA Safer Choice or Design for Environment programs.

## California to allow non-FR polystyrene foam insulation

California Building Standards Commission voted on 19<sup>th</sup> January 2019 to authorise the use of non-flame-retardant expanded polystyrene foam (EPS) insulation in specific circumstances buildings. This concerns only use in horizontal applications in foundations underneath 3.5 inch (8 cm) concrete. The [InsulationValues](#) website (Dow Dupont) indicates that this decision ignored the opinion of the Commission's expert committee. The [study](#) commissioned to Oklahoma University to inform the proposed code change showed that non-FR EPS foam was much more easily ignited and flammable than FR EPS foam, but concluded that the non-FR foam was did not pose a higher risk than other flammable materials stored on building sites, and did not pose a significant fire risk as used in foundations, even if accidentally partially exposed. This report recommended that rulemaking to require flame retardancy of ABS piping be considered, because this was more flammable than the other construction materials tested (EPS foams, rolled polyethylene sheetings), and that all flame retardants should be evaluated for possible health and environmental impacts.

*"Flammability Standards for Building Insulation Materials, Phase II Working Group Report: Final Report August 17, 2017"*, [https://osfm.fire.ca.gov/codedevelopment/pdf/CalFire-OSU\\_Phase\\_II\\_Working\\_Group\\_Final\\_Report.pdf](https://osfm.fire.ca.gov/codedevelopment/pdf/CalFire-OSU_Phase_II_Working_Group_Final_Report.pdf) and *"Why Did the California Building Standards Commission Just Approve An Unregulated Building Product?"*, 24 January 2019, <https://www.insulationvalues.com/accountability/2019/1/24/why-did-the-california-building-standards-commission-just-approve-an-unregulated-building-product>



SAFER  
CONSUMER  
PRODUCTS

## California testing of FRs in children's sleeping products

The California administration DTSC (Department of Toxic Substances Control) has published results of testing of children's foam-padded seep products, to verify compliance with the July 2017 ban of TDCPP\* and TCEP\*. Analysis of 21 products purchased from major online retailers did not find these two FRs at levels indicating that they had been included deliberately. These two FRs were found at "relatively low levels": 56 and 348 ppm respectively. Four products did however show significant levels of other FRs (three different halogenated FRs), at 900 – 58 000 ppm. These were however in some cases products manufactured before 2017. DTSC concludes that no further compliance actions are justified at present.

\* TDCPP tris(1,3-dichloro-2-propyl) phosphate, TCEP and tris(2-chloroethyl) phosphate.  
*"Testing Children's Foam-Padded Sleeping Products in California: A Summary of Findings"*, Department of Toxic Substances Control Safer Products and Workplaces Program, January 2019 <https://dtsc.ca.gov/SCP/upload/SCP-Nap-Mats-Sampling-Report.pdf>

## Product recalls

Several consumer products have recently been found to pose fire risks, with in each case reports of smoke, fire and property damage. 164 000 Brookstone wireless speakers, in which faulty lithium ion batteries have caused fires; 137 000 Haier refrigerators. Ford have recalled 2 million F-150 pickup trucks in the USA, Canada and Mexico, following fires starting in seat belt pre-tensioners, with reports of three vehicles having been completely destroyed by fire.

CPSC product recalls: Brookstone wireless speakers: <https://www.cpsc.gov/Recalls/2018/brookstone-wireless-speakers-recalled-due-to-fire-hazard>  
Haier refrigerators <https://www.cpsc.gov/Recalls/2019/Haier-America-Recalls-Top-Mount-Refrigerators-Due-to-Fire-Hazard>  
Ford F150 pickups <https://media.ford.com/content/fordmedia/fna/us/en/news/2018/09/06/ford-issues-safety-recall-in-north-america-for-select-2015-18-fo.html>





## Canada consults on revised tent flammability standards

The Canada Government is consulting on proposals. The consultation presentation notes that there were 30 deaths and 40 injuries from tent fires in the fifteen years 1972-1987, before flame retardancy of tents was initially required in 1988, then updated in 1995. The 1995 fire safety requirements (CPAI-84) were intended for cotton canvas tents, as largely used at the time, whereas today's tents are mostly lighter, synthetic materials (e.g. polyester, nylon). The proposed new standard CAN/CGSB-182.1 includes a weathering procedure and includes flammability tests for both wall and floor materials. For the wall materials, a vertical test with average mass loss, damaged length and flaming debris requirements is suggested, but the after-flame requirement is removed. This test can also optionally be used for the floor materials. It is noted that an objective of the new standard is to enable the standard to be met without using flame retardants. The proposal is open to comment to **23<sup>rd</sup> March 2019**.

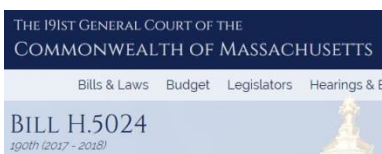
*"Notice to interested parties – Proposal to amend the Tents Regulations, including consequential amendments to the Toys Regulations", Health Canada, 22 January 2019*  
<https://www.canada.ca/en/health-canada/programs/consultation-amend-tent-regulations/document.html> **Consultation open to 23 March 2019**



## Singapore personal mobility devices (PMDs) standard

Registration of personal mobility devices (PMDs), which have an electric motor and a handlebar (e.g. electric scooters) has been made obligatory in Singapore from 2<sup>nd</sup> January 2019. Only UL 2272 Certified models will be authorised for use in public places after December 2020, with the objective of reducing risks from fire. There were some 40 fires involving PMDs in Singapore in 2017. UL 2272 includes evaluation of the safety of PMD electrical systems and batteries, which are critical to fire safety. Application of UL 2272 has also been [recommended](#) by the US Consumer Products Safety Commission.

*Singapore LTA (Land Transport Authority) requirements:*  
<https://www.onemotoring.com.sg/content/onemotoring/home/buying/vehicle-types-and-registrations/E-Scooters.html#check> UL 2272 <https://www.ul.com/hoverboards/>



## Massachusetts flame retardant bill blocked

A bill ([H.5024](#)) proposing to ban ten halogenated flame retardants and antimony trioxide in a wide range of products in Massachusetts has been rejected by the State Governor for reasons of timing and wording, but with his support to move forward such a bill in the future. The proposed text would have banned from sale, within a few months, bedding, carpets, children's products including car seats, furniture or window treatments. Elsewhere, a ban on sale of home furniture containing any flame retardant came into force in the State of Maine on 1<sup>st</sup> January 2019 (see pinfa Newsletter n°84), as did a ban on flame retardants in furniture and certain children's products in San Francisco (pinfa Newsletter n°86).

*"Mass. Governor vetoes flame retardant furniture ban" January 14<sup>th</sup> 2019*  
<https://www.firerescue1.com/legislation-funding/articles/393294018-Mass-governor-vetoes-flame-retardant-furniture-ban/>



## Environmental standard references GreenScreen

The US standards health and safety organisation NSF International has updated its standard NSF/ANSI 426 – 2018 “Environmental Leadership and Corporate Social Responsibility Assessment of Servers”. The criteria include as obligatory “reduced” levels of bromine and chlorine in plastic parts > 25g (<1000 ppm chlorine or bromine, <5000 ppm in post-consumer recycled plastics), but printed circuit boards, cables, fans and electronic components are exempted. The criteria also include an optional requirement that a hazard assessment be required of flame retardants. The criteria indicate that this should be “comparable to” GreenScreen, should cover all plastic parts > 25g (with similar exemptions to above), and should also consider “transformation products including those from combustion”. The optional requirement applies to flame retardants, plasticisers and principal solvents used in final assembly.

NSF/ANSI 426 – 2018 <https://greenelectronicscouncil.org/wp-content/uploads/2018/06/NSF-ANSI-426-2017-Environmental-Leadership-and-Corporate-Social-Responsibility-Assessment-of-Servers.pdf>



## California repeals standards for public furniture

The State of California has repealed requirements for flammability resistance (TB133 open flame test) for furniture in public buildings (public spaces in hotels, prisons, hospitals, schools, auditoriums and stadiums ...). Furniture in these buildings will now only have to pass the TB114-2013 “smolder resistance” test (the same as for domestic upholstered furniture). The repeal of this fire safety requirement is based on the claim that “it reduces the public’s exposure to carcinogenic organohalogen flame retardants”.

*California Bureau of Electronic and Appliance Report, Home Furnishings and Thermal Insulation (BEARHFTI) amends furniture flammability standards by removing requirements of Technical Bulletin 133, “Flammability Test Procedure for Seating Furniture For Use in Public Occupancies”, 23 January 2019*

[https://bhqs.dca.ca.gov/bureau\\_activities/regulatory\\_changes.shtml](https://bhqs.dca.ca.gov/bureau_activities/regulatory_changes.shtml)

*Chemical Watch 31 January 2019 “California repeals business furniture flammability standard”*  
<https://chemicalwatch.com/73872/california-repeals-business-furniture-flammability-standard>

## 24 000 home electrical fires in the USA

Some 24 000 electrical fires per year occur in US homes (2014-2016), causing 310 deaths, 850 injuries and nearly 900 million US\$ property loss. Electrical fires result in property value losses double those of other fires on average, and remain limited to the object in which the fire starts in less than one fifth of cases. The first item ignited was mostly wire or cable insulation (31%) or building structure (18%). Causes include electrical equipment malfunction (43%), short-circuits and arcing and defective or worn insulation. The report notes that today’s electrical devices, increasing in number, can overburden wiring and electrical systems in older homes, and are also caused by ageing of wiring insulation, loose or worn connections, or oil or dirt causing electrical component overheating.

*U.S. Fire Administration – FEMA, “Residential building electrical fires (201-2016)”*  
<https://www.usfa.fema.gov/downloads/pdf/statistics/v19i8.pdf>





## Over 3 500 fire deaths in the USA

The US fire administration report on fire risk (2016) indicates that 3 515 people died in fires in 2016 and 14 650 people were injured. The risk of fire death was higher for adults over 50, and highest over 85, but also important for young children (up to 4). Fire risk was also higher by race and for lower income households, showing the social inequality of fire risk. The report notes that today only 3% of US homes are not equipped with a smoke alarm, but does not provide data on whether or not these were functional or whether they sounded in fires.

U.S. Fire Administration - FEMA "Fire risk in 2016"  
<https://www.usfa.fema.gov/downloads/pdf/statistics/v19i6.pdf>



## Ten dead in Paris apartments fire

10 people died and 96 were injured in a fire in an apartment building, rue Erlanger, Paris, in the night of 4-5 February. The fire is thought to have been deliberately started by a 40-year old woman who had just been released from psychiatric hospital with medical clearance (her thirteenth stay in psychiatric hospital). She was arrested drunk after the fire and neighbours say she was threatening to "blow up" the building earlier in the evening. Indications suggest that several fires were started at different points in the building. The building had "[no known defaults](#)" but was situated within a courtyard, making it impossible for fire fighters to access other than with hand-held ladders. This human disaster again shows how fast and fatally fire spreads through residential buildings today.

"Paris fire: the suspect indicted" <https://www.la-croix.com/France/Justice/Incendie-Paris-suspecte-mise-examen-2019-02-09-1201001383> and "Update on the fire rue Erlanger Paris XVI" <https://www.paris.fr/erlanger>



## No injuries in German high-speed train fire

510 passengers were evacuated safely after fire broke out in an ICE high-speed train from Cologne to Munich on 12<sup>th</sup> October 2018. A policeman in the train smelled smoke and pulled the emergency break alarm. There were no injuries from the fire. The fire started in the second-to-last carriage, which was completely destroyed, and damaged another carriage. A technical fault in a transformer may have caused the fire. This incident shows the effectiveness of the demanding fire safety requirements for materials used in railways.

Press coverage <https://www.dw.com/en/fire-on-german-high-speed-train-forces-evacuation/a-45865116> Video (Das Erste) <https://www.youtube.com/watch?v=w2VoVCSgRCE>



## Bangladesh slum fire kills nine, hundreds homeless

A fire in a shanty town in the port city of Chittagong, Bangladesh, on 17<sup>th</sup> February, killed nine people and destroyed around five hundred slum homes of bamboo, tin and tarpaulin. Slum areas in developing countries are at high risk of fire, because of flammable materials, open cooking, absence of fire gaps and difficult access for fire services. Additionally, fires may be started deliberately to clear areas by authorities or property developers (see Xinjiang, Beijing fire, November 2017 in pinfa Newsletter n°89). Bangladesh human rights activist Nur Khan Liton stated "We have seen fires

are used as a weapon to evict poor slum dwellers and squatters from government or private property”.

*Bangladesh Chittagong fire, 17 February 2019* <https://www.gulf-times.com/story/622524/Nine-dead-in-Bangladesh-slum-fire> and <http://www.nationmultimedia.com/detail/breakingnews/30364273>



## 17 die in New Delhi hotel fire

A fire at the Arpit Palace Hotel, Karol Bagh area, New Delhi, India (see hotel on [TripAdvisor](https://www.tripadvisor.com)) killed 17 hotel guests. The fire is thought to have started with a short-circuit in an air conditioner of a room in the hotel and been exacerbated by wooden panelling in corridors. The owner and managers of the hotel have been arrested with media reports stating that the air conditioner may not have been serviced, that the hotel was lacking alarms and fire extinguishers, an emergency exit was locked and that the hotel's fire safety certificate had been delivered through a breach of procedure by an official from a different zone. Fire safety certificates of 15 other hotels and restaurants in the area have now been suspended.

*Arpit Palace Hotel fire, New Delhi, 12 February 2019* <https://www.bbc.com/news/world-asia-india-47208379> - <https://www.tribuneindia.com/news/delhi/fire-karol-bagh-hotel-owner-arrested/730701.html> - <https://www.hindustantimes.com/delhi-news/karol-bagh-hotel-inferno-fire-certificates-given-by-officer-from-another-zone/story-tg37bGKGimxi9ggcK13HqN.html>



## Lubrizol launches non-halogen FR polymer

Lubrizol (Performance Coatings) has launched a new non-halogen, self-crosslinking acrylic-based flame retardant polymer technology, Hycar NH3069, which imparts both fire resistance and mechanical performance to materials including textiles (cotton, synthetic fibres), paper, and glass fibers. The waterborne product can be applied in a variety of methods including padding, knife coatings, gravure, and screen printing. The applied product is water durable to TAPPI T461 extraction method. Potential applications include air filtration media, wall paper, interior decorations, transport textiles, and upholstered furniture. Fire performance DIN 53438 (parts 2 & 3), NFPA 701 (vertical) and MVSS302 (horizontal) are achieved on treated materials. The material is not Classified under GHS.

*“Lubrizol Introduces Non-Halogen FR Technology - Flame Retardant Performance Without Additives”, 5 February 2019* <http://newscenter.lubrizol.com/phoenix.zhtml?c=250972&p=irol-newsArticle&ID=2386349> and product information <https://www.lubrizol.com/Coatings/Products/Hycar-NH3069>

## LSZH for performance electronics cables

L-com Global Connectivity, a leading electronics connectivity product supplier and part of the Infinite Electronics group, has launched a new range of high performance electronics cables. Low Smoke Zero Halogen, available off the shelf, to ensure both fire performance and low combustion toxicity. Cables available include Cat. 6a Ethernet, USB and audio 3.5 mm jack cables, available in red, black and blue. Both the cables themselves and the connector overmolds are LSZH to optimise protection of people and equipment from corrosive gases in case of fire.

*“L-com Debuts Low-Smoke Zero-Halogen USB 2.0 Cables with Ferrites”, 24 September 27, 2018* <http://www.l-com.com/content/Article.aspx?Type=P&ID=10760>

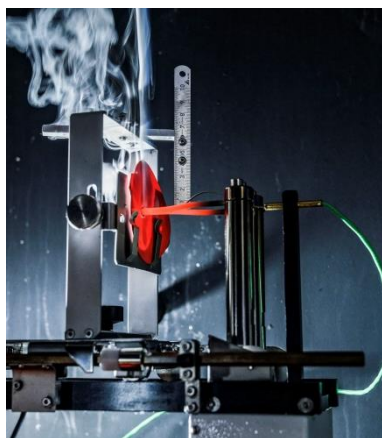




## Solvay polymers to make Smart Cities safer

Solvay Performance Polyamides has added new compounds to its range of non-halogenated flame retardant polyamides (see pinfa Newsletters n°39 and 68), adapted for applications in miniaturised electrical and electronic equipment. At only 0.4 mm thickness, UL94-V0 and Glow Wire Ignition Temperature 800°C can be achieved. High processing performance reduces scrap in production and offers low injection tool corrosion, contributing to sustainability. The products specifically target the objective of ensuring fire safety in digital cities, where electronics and connectivity are ubiquitous and inter-connected, and fire safety is essential for equipment operating autonomously, including applications such as smart meters and circuit breakers.

*“Technyl® One New Generation: the Safety and Environment Insurance for Digital Cities”, Solvay press release, Lyon, France, 18 December 2018 <https://www.technyl.com/technyl-one-new-generation-the-safety-and-environment-insurance-for-digital-cities/>*



## Speciality PIN FR polymers for electrical fire safety

Lanxess has extended their performance PIN flame retardant PBT-based polymers (polybutylene terephthalate) by a new product offering high glow wire resistance, adapted to ensure fire safety of electrical equipment and electrical vehicles. The new material is certified to GWIT (glow wire ignition temperature) of 775°C for thickness down to 0.75 mm, as well as UL94-V0 at 0.4 mm, and also offers electrical safety performance with a high tracking index, better than materials using halogenated flame retardants. It also offers UV resistance, low corrosion in contact with currents and high thermal stability (relative temperature index of 140°C or higher, UL 756B). The first in the product range is a compound material available unreinforced and with glass fibre contents of 25% – 30%. Applications include household appliances, especially those intended to operate unattended (for which fire safety is critical), such as washing machines or dishwashers, and also demanding components such as electrical vehicle battery chargers.

*“LANXESS expands product range of halogen-free flame-retardant PBT compounds. High glow wire resistance protects at home and on the road”, 16 October 2018 <https://lanxess.com/en/corporate/media/press-releases/2018-00071e/>*

## Performance designer textile

Kvadrat, a leading European textile design company, and Copenhagen-based designer Karina Nielsen Rios, have launched a line of outdoor upholstery fabrics aimed to be hardwearing and “eco-friendly”, under the brand ‘Patio’. The textiles use the flame retardant fibre polymer Trevira CS, based on polyester, which provides durability for outdoor use. They are treated to ensure resistance against seawater (chlorine), humidity (liquid repellent and fast drying) and weathering for outdoor use, soft to the touch, and offer colour effects by combining two colours in the warp and one in the weft, including both natural and bold tones for “colour vibrancy”. Applications include outdoors, high humidity areas such as spas, in furniture, screens, parasols.

*“Kvadrat debuts eco-friendly and “sporty” Patio outdoor fabrics”, 16 January 2019 <https://www.dezeen.com/2019/01/16/kvadrat-debuts-eco-friendly-and-sporty-outdoor-fabrics/>*







## NHFR pallets offer proven durability

Rehring Pacific has launched new NHFR (non-halogenated flame retardant) grocery pallets offering both tested fire performance and proven durability. The pallets are standard 1 x 1.2 x 0.142 m, stackable 570 pallets to a trailer. They meet Factory Mutual (FM) Standard 4996 for fire performance of empty pallets, reducing fire risks in storage areas. They have also been tested by Virginia Tech University to simulate 200 cycles of transport and use in warehouse and supply chain conditions, proving durability. Rehring Pacific has over a century of experience in reusable transport packaging and offers expertise in global supply chain management, with strong commitment to sustainability.

*"Rehring Pacific GMA Pallets Now Certified by FM Approvals" 3 January 2019*

<https://www.rehringpacific.com/rehring-pacific-gma-pallets-now-certified-fm-approvals/>



## Australia funding for flame retardant research

The Australia Government has awarded 3 million UAS\$ (around 1.9 million €) funding to a 8 million AUS\$ project to develop "eco-friendly, non-toxic, durable flame retardants" for polymers and textiles. The project is engaged by the University of New South Wales and Sweden-based [company](#) Flame Security International. Australia Ministers for the Department of Industry, Innovation and Science "Fighting fires with science", 19 July 2018 <https://www.minister.industry.gov.au/ministers/seselja/media-releases/fighting-fire-science> and Flame Security International <http://flamesecurity.se/hem/product-information-in-english/>

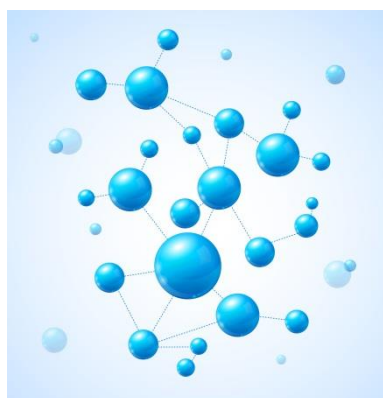


## Researchers develop FR from used coffee grounds

Nanyang Polytechnic, Singapore, has presented to media development of a flame retardant for epoxy resin produced from used coffee grounds, achieving UL94-HB rating for epoxy in lab tests (thickness not specified). It is not indicated what properties of the coffee are thought to give this result. As could be expected, the coffee waste gives a brown colour to the epoxy, which could limit applications.

*"NYP team turns coffee waste into fire retardant", 14 January 2019*

<https://www.channelnewsasia.com/news/singapore/nyp-team-turns-coffee-waste-into-fire-retardant-11121418>



## Bio-based phosphorus FR for polypropylene

Phytic acid is widely present in seeds and other plant parts, and naturally has a high phosphorus content. In this study, phytic acid was reacted with piperazine (a nitrogen containing molecule) a molar ratios of 6:1 – 2:1 piperazine/phytic acid.. The resulting substance ("PHYPI") was tested to flame retard polypropylene (at 0 – 25% weight). The phytic acid based phosphorus FR showed to be effective in polypropylene, reducing peak heat release by 66% and peak smoke release by 33% (at 20% FR loading); and achieving UL94-V0 (3.2 mm). Analysis suggests that the flame retardant effect resulted from generation of carbon double bond and P-N-C structures which improved char formation, but also maybe release of water and carbon dioxide reducing fire gases.

*"A novel bio-based flame retardant for polypropylene from phytic acid", Y-Y. Gao et al., Polymer Degradation and Stability 161 (2019) 298e308*

<https://doi.org/10.1016/j.polymdgradstab.2019.02.005> See also Feng et al., FR for cotton based on phytic acid and urea, pinfa Newsletter n°84

## Zinc borate and magnesium hydroxide reduce smoke

Synergistic action of zinc borate or magnesium hydroxide with phosphorus were demonstrated in novel PIN FR coatings applied to 4mm plywood board (up to 75x75 cm, tunnel, cabinet tests, cone calorimeter and smoke density tests). A cyclic phosphate ester was reacted with zinc borate or with magnesium hydroxide, then incorporated into an amino resin, then brush applied to the plywood, with several applications to result in a 0.4 mm coating. Different levels of minerals were tested (0 – 7% by mass). The addition of zinc borate at 7% halved the flame spread rating (FSR) of the plywood, nearly halved the total heat release and reduced the peak smoke production rate and total smoke release to around one third. Magnesium hydroxide showed optimal performance at 5%, reducing total heat release and peak smoke production by around 30% and reducing total smoke release by just around 55%. Analysis suggests that these effects were due to formation of a more compact and intumescent char layer, in particular by increasing phosphorus cross-linking. Coating opacity is somewhat increased by the zinc borate, but it remains transparent.

*“Synergistic flame-retardant and smoke suppression effects of zinc borate in transparent intumescent fire-retardant coatings applied on wood substrates”, L. Yan et al., Journal of Thermal Analysis and Calorimetry 2018 <https://doi.org/10.1007/s10973-018-7819-1>*

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

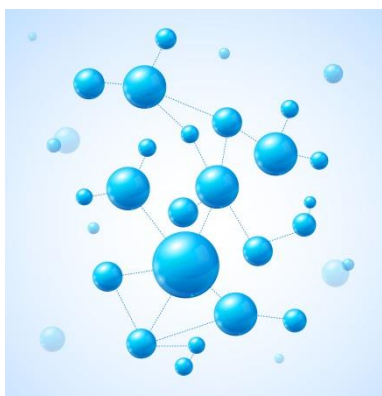
## STPP and pomegranate FR for cotton

In laboratory tests, 3% STPP (sodium tri poly phosphate, the mineral phosphate salt widely used last century in detergents) and pomegranate rind extract were tested as a “green” PIN flame retardant treatment for cotton (150 g/mm<sup>2</sup> woven fabric). The extract was obtained by high temperature boiling in water of chopped waste pomegranate rinds. The cotton was soaked in STPP and then extract for 30 minutes each at 90°C, then dried. The pomegranate extract includes nitrogen-containing alkaloids, which are considered to contribute to flame retardancy, and metal ions which react with the negative STPP ions. The combined treatment achieved self-extinguishing in the cotton, but caused brown discoloration, and was not wash durable. Wash durability was however obtained by treating with citric acid and a phosphorus-based catalyst.

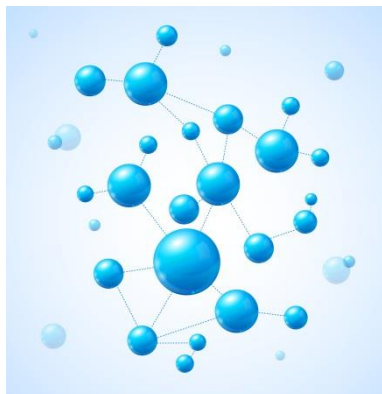
*“Sodium tri-polyphosphate in combination with pomegranate rind extracts as a novel fire-retardant composition for cellulosic polymer”, S. Basak & S. Wazed Ali, Journal of Thermal Analysis and Calorimetry <https://doi.org/10.1007/s10973-019-08034-w>*

## Mineral functionalised LDHs as PIN FRs for epoxy

Functionalised layered double hydroxide (LDH) were synthesised in a one-step reaction by mixing a solution of organic compounds (SDBS sodium dodecylbenzenesulfonate, sCD hydroxypropyl-sulfobutyl-beta-cyclodextrin and taurine) with solutions of magnesium nitrate Mg(NO<sub>3</sub>)<sub>2</sub> and aluminium nitrate Al(NO<sub>3</sub>)<sub>3</sub> and adjusting pH, then filtering and drying the resulting slurry. The resulting nano LDHs were incorporated into epoxy by mixing, acetone dissolution, then vacuum heat drying. With 6% LDH loading, UL94-V0 (3.2 mm) was achieved, peak heat release rate was reduced to around one third of that of pure epoxy, and total smoke production was also reduced nearly to one third. Reduction of epoxy impact and tensile strength was limited.



*"Functionalized layered double hydroxide-based epoxy nanocomposites with improved flame retardancy and mechanical properties"*, E. Kalali, *J. Mater. Chem. A*, 2015, 3, 6819–6826  
<https://doi.org/10.1039/c5ta00010f>



## Renewable cellulose and clay for FR coating

Researchers have tested layer-by-layer deposition (LbL) coating on PET film and on polyurethane foam (not specified), alternating cellulose nano-fibrils and clay. The cellulose nano-fibrils were extracted from pulp fibres, then cationised. These fibrils are expected to show good mechanical properties because of crystallinity. The clay was anionic vermiculite clay (of mineral origin) as nano-platelets. Alternate deposition (by simple dipping, rinsing, drying) of the two oppositely charged materials resulted in a nano-scale coating with high levels of structure and of clay platelet alignment. A twenty bilayer coating (total thickness c. 140 nm) showed low oxygen transmission (reducing 180 µm PET film transmission from 17.5 to 0.03\*), high elasticity modulus and hardness. Two (or four) bilayers on polyurethane foam (4.4% weight of coating) reduced mass loss in a 10 second butane torch test from 100% to 31% (26%) and prevented melt-dripping. The authors conclude that this LbL technology, using renewable components, could potentially provide effective fire protection to a range of materials and applications.

\* unit for oxygen transmission:  $\text{cm}^3/\text{cm}^2/\text{cm}^2\text{-s Pa}$ .  $10^{16}$

*"Super Gas Barrier and Fire Resistance of Nanoplatelet/Nanofibril Multilayer Thin Films"*, S. Qin, J. Grunlan et al., *Adv. Mater. Interfaces* 2019, 6, 1801424  
<http://dx.doi.org/10.1002/admi.201801424>



## Struvite for PIN flame retardancy of wood

Struvite (magnesium ammonium phosphate) is today recovered from municipal wastewater, food industry waste streams and other wastes. It enables phosphorus recycling as a fertiliser, but has also been tested as a PIN flame retardant for cotton and wood by Yetilmezsoy et al. 2018 (simply placing powdered struvite in or on the material). In a second paper, Guo et al. generated struvite in situ within wood (0.8 mm Norway spruce veneer), by vacuum impregnation of the wood with magnesium sulphate and potassium phosphate aqueous solutions (3 x 1 hour), wiping clean, then fumigation by ammonia for 10 hours, then leaching to remove remaining soluble salts. This resulted in just over 20% (by volume) loading of struvite in the wood. The struvite mineralised wood veneer could not be ignited by a small flame (untreated veneer ignited in two seconds) and showed an LOI (Limited Oxygen Index) nearly tripled. The authors suggest that struvite acts as a FR by absorbing energy in decomposition in heat, releasing non flammable gases and water, and by releasing amorphous magnesium phosphate ( $\text{MgHPO}_4$ ) which promotes char formation.

*"Utilization of Struvite Recovered from High-Strength Ammonium-Containing Simulated Wastewater as Slow-Release Fertilizer and Fire-Retardant Barrier"*, K. Yetilmezsoy et al., *Environ. Technol.* 2018 <https://doi.org/10.1080/09593330.2018.1491642>

*"Bioinspired Struvite Mineralization for Fire-Resistant Wood"*, H. Guo et al., *ACS Appl. Mater. Interfaces* 2019, 11, 5427–5434 <https://doi.org/10.1021/acsami.8b19967>

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