AMI | Events

Fire Resistance in Plastics

AMI Fire Retardants in Plastics (USA) 2023, 26-27 April 2023, Philadelphia www.ami.ltd/event-fire-USA

Flame Resistance in Plastics (Europe) 2023, 20 - 22 November 2023 www.ami.ltd/event-fire
Westin Grand Hotel, Berlin**, Germany**

AMI conferences: https://www.ami.international/events

This Special Issue of the pinfa Newsletter summarises the **17th Fire Resistance in Plastics Conference 2022** (AMI FRiP) that has taken place in Cologne on 28-30 November 2022. The conference brought together some 150 participants from 22 countries, mainly from industry (flame retardant, synergist and polymer producers, compounders and masterbatchers, plastics formulation and application advisors, equipment manufacturers) and R&D specialists. This Conference is the only flame retardant industry conference in Europe, and a unique networking opportunity. Presentations at FRiP relevant to PIN flame retardants only are summarised here (three presentations on brominated FRs are not covered).For summaries of recent previous editions see pinfa Newsletters n°s 34, 61, 76, 88, 98, 109, 124, 134.

The conference was chaired by Peter Mapleston, freelance journalist for Compounding World

CONFERENCE SUMMARY
REGULATORY AND MARKET PERSPECTIVES

Adrian Beard (pinfa) summarised **policy and stakeholder trends impacting flame retardant chemical selection** in Europe and in North America. The EU Green Deal and its Chemical Strategy for Sustainability will greatly accentuate sustainability requirements for flame retardants in Europe, accelerating bans of chemicals with health or environment questions, introducing new Hazard classes, requiring information on LCA and recycling, introducing registration or declaration of all polymers and with possible regulatory "grouping" of flame retardants. A study for Cefic (Ricardo et al. 2021) suggests that nearly a third of current chemicals turnover could be banned or restricted. pinfa has commissioned a study showing that "grouping" of phosphorus FRs is partly possible, but with significant differences between several classes, and need to take into account exceptions (see pinfa Newsletter n°142). In the USA, actions against FRs by some States continue to develop, often without clear targeting, resulting in a patchwork of unstable and evolving restrictions in some States for some applications and an overall negative image of flame retardants. There is a general trend to continue to further restrict halogenated FRs across North America, for example the current proposal to ban DBDPE (Decabromodiphenyl ethane = Dechlorane plus) in Canada.

Micaela Lorenzi, Green Chemicals (pinfa member), compared **recent developments in PIN and halogenated flame retardants for engineering polymers**. The global market for flame retardants is around 2.2 million tonnes/year, growing 3% annually. Today, only around one third of global FR volumes are halogenated/ATO and there is growing regulatory pressure and scientific health and environment concerns about halogenated flame retardants. Prices of both brominated and some PIN flame retardants have increased significantly over the last year, in particular for phosphorus FRs. Challenges for PIN flame retardants compared to halogenated are generally considered to include the need for higher loadings, thermal stability and higher prices, but differences are being reduced as PIN FR technologies evolve. Challenges in recycling, where breakdown of FRs can release acids or radicals, can be addressed by specific additives and co-polymers. Polymeric phosphorus PIN FRs, such as polyphosphonates, offer advantages, and synergy with other PIN FRs (melamine compounds, Depal), but application is specific to different polymers.

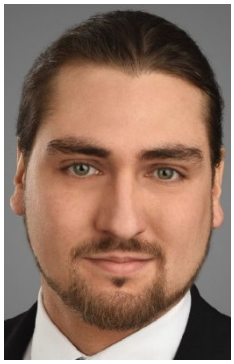
Markus Kemmler, Kemmler Consulting (see also interview below), presented different fire resistance specifications for cables in Europe and in the USA, and relevant testing methods. The Construction Products Regulation is now the reference in Europe. Specifications are harmonised, but the level of performance required varies between different Member States' building regulations. An incoherence is that CPR and Building Regulation requirements do not apply to cables in machinery in buildings, only to fixed cables and wiring. The tendency in Europe is towards HFFR (Halogen Free Flame Retardant) cables. Fire safety challenges are to ensure continuity of functioning of the cable in fire (transmission of energy or of communications signals), to ensure that cables cannot spread fire between different building compartments, and to limit fire risk as quantities of cables accumulate in buildings over time. Another challenge for industry is that different testing labs often generate different test results for the same cable, depending on cable diameter, sample provided (batches are not necessarily fully homogenous) but also on laboratory set up and staff implementation of test procedures. Reliability of CPR testing has however been improved, and is now generally better than other tests.

COMPANY INTERVIEWS:
DELIVERING FIRE SAFETY FOR END-USE APPLICATIONS

Patricia Lamouche, Hager Group

Flame retardants are essential for Hager to ensure fire safety and to respect applicable product standards. Access to full chemical data on all molecules in plastics compositions is a priority to support Hager's sustainability roadmap and to ensure respect of end-user obligations under chemicals regulations. This includes, in particular, avoidance of substances included or to be included in RoHS Directive (Restriction of hazardous substances in electrical and electronic equipment), SVHC (Substance of Very High Concern) or POP substances (Persistent Organic Pollutants). This could become problematic if the proposed Green Deal revision of REACH adds further requirements for substances such as flame retardants because suppliers often do not supply full information to end-users. In order to support the eco-design approach, Hager performs Life Cycle Assessment for its end-products, however the lack of information on flame retardants in environmental databases remains a challenge. Hager is looking for sustainable FR solutions with thermal stability in processing, enabling improved product mechanical stability. Hager is already using some recycled plastics (e.g. from end-of-life fridges) and is looking to use more secondary materials, if recyclers can develop supply while meeting reliable fire resistance performance. Hager is open to further cooperate with FR suppliers and compounders on environment and LCA, ageing and recycling.

Hager manufactures electrical distribution, installation, wiring, connection and safety systems for residential and commercial buildings. Hager is an independent family company since 1955, with today 12 100 employees and 22 production sites worldwide. https://hagergroup.com/



Christoph Karpe, Wulfmeyer Aircraft Interior

Requirements for fire performance and low smoke in aviation mean using PIN flame retardants with constant R&D to meet tightening requirements. Despite the same fire safety and low smoke objectives in other sectors (automotive, building), performance PIN FR solutions developed for aviation are often not used for reasons of cost. POSS (see Bioenvision presentation) can be an effective synergist, enabling achievement of fire and smoke requirements with lower PIN FR levels, so better materials performance. Challenges for aviation material suppliers are demanding technical requirements (for example bonding foams to aluminium), increasingly tight fire safety specifications, and difficulties to well mix FRs into polymers (poor compatibility). Combinations of materials are needed to achieve performance requirements, but complex testing of these can limit innovation.

Rudolf Wulfmeyer Aircraft Interior GmbH&Co.KG is a supplier and partner of the international aviation industry since over 60 years, initially supply aircraft seats covers, and today supplying specialised materials including non-textile flooring, thermal acustic insulation foams (body panels, wastewater systems, …), non-textile floor coverings, adhesive tapes, hook & loop fasteners. www.wulfmeyer.com

COMPANY INTERVIEWS:
FRS FOR SPECIALIST CABLES, FILMS, COATINGS

Markus Kemmler, Kemmler Consulting

Cable producers today often try to meet, with the same non-halogenated product, the fire test requirements of Europe, China and the USA. This is highly challenging, and can be economically not feasible or result in processability problems. The general move towards HFFR (Halogen Free Flame Retardant) means replacing PVC by more complex formulations, in which non-halogenated polymers are loaded with PIN flame retardants. This leads to lower mechanical performance compared to PVC alone, and difficulties to achieve specifications such as tear strength and elongation. Cable producers are today looking for a non-halogenated polymer with fire resistance to economically replace PVC. A difficulty is that the cable producers do not dialogue directly with the polymer and FR industries, because they generally use formulations provided by compounders. A specific need is for PIN FR solutions for TPU (thermoplastic polyurethane) which can achieve US NFPA 262 requirements whilst ensuring mechanical performance.

Kemmler Consulting has 30 years of experience in cable polymer formulation and implementation, material sourcing, compounding through to cable manufacture. Kemmler Consulting has today three associate experts. www.kemmler-consulting.de

Rina Lupu-Matas, Avery Dennison

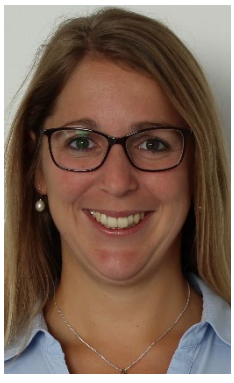
High-performance FR materials are needed to be compatible with resins, to formulate and apply as thin coatings on films with specific properties. Avery Dennison Hanita coated films (e.g. polyester) are used in widely varying applications, with demanding and particular functions, including e.g. print substrates, labels, heat insulating panels for building and construction, laminated blinds (textile/PET), tapes for the automotive and EV markets. The coating process is a high-volume, roll-to-roll continuous process. There is an increasing demand for non-halogenated FR solutions, particularly in automotive, to avoid the risk of halogen compound release in end-of-life recycling. Halogen-free in electronics is already a standard. Thinner films and coatings offer lower materials cost and lower weight but require very fine particles to ensure a smooth gloss or satin finish. One challenge for PIN FR solutions is compatibility with water-based (non-solvent) coating applications to offer a more sustainable solution.

Avery Dennison is a global materials science company with 36,000 employees in 50 countries, specialising in labelling and functional materials, particularly pressure-sensitive and adhesive materials for labels, bonding tapes, and RFID (radio frequency identification) solutions. Avery Dennison products are used in almost every major industry sector. www.averydennison.com/en

CONFERENCE SUMMARY
INDUSTRY PIN FR INNOVATIONS

Franck Gyppaz, Nexans, underlined the importance of cables for fire safety and presented a new mineral PIN flame retardant solution. Quantities of cables are increasing everywhere, with demography and with increasing energy demand and new energy uses. One quarter of fires are of electrical origin. Although fires mostly start at the interfaces with components and connections, cables can be critical in fire propagation. Current non-halogenated FR solutions for cables imply high filler loadings which deteriorate cable mechanical properties. Nexans has developed a new PIN FR technology combining silicate, a base-releaser, a specific metakaolin with a reaction control additive and a carrier to ensure compatibility with cable materials. These react together in fire to form a concrete-like material which provides low-smoke fire resistance and maintains physical integrity. The FR solution can be delivered in a biopolymer-based tape rather than compounded into the cable polymers, enabling to achieve CPR B2ca-s1,d0 when protecting EPDM accessories (ethylene propylene diene monomer rubber). A tape based solution can replace cable bedding, giving higher cable flexibility, or could be applied to polymer plates and other materials.

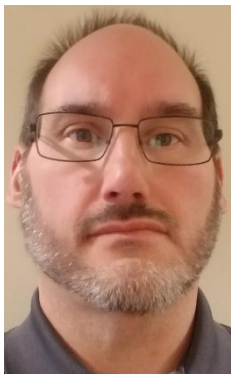
Sebastian Hörold, Clariant (pinfa member) outlined **developments in phosphinates as performance fire safety solutions for engineering plastics**, in particular in response to demanding specifications for e-mobility. Non-halogenated FRs offer better electrical performance (CTI comparative tracking index) because antimony (ATO) is not used. Clariant has developed two new phosphinate PIN FR - synergist packages enabling improved glow wire ignition test performance (GWIT to 800°C @ 0.75 mm) and UL 94 V-0 @ 0.4 mm (for both, at 23% loading). Mechanical performance approaches that achieved with brominated FRs. REACH registration is completed. Depending on the FR-synergist package, high thermal stability (broad processing window), no blooming, water resistance and low density are possible. Phosphinates also combine fire safety, electrical and material performance for epoxies, PBT, TPU and polyurethanes for electric vehicle applications such as charging and high voltage connectors, battery structure and housing, adhesives, busbars.



Corina Neumeister, Nabaltec, presented a **new mineral PIN FR system producing a structural ceramic protective layer in case of fire**, corresponding to specifications for electric vehicles and other demanding applications, where rapid fire protection, maintaining of structure and prevention of fire heat transfer are all required. Mineral FRs alone result in fragile ash. The new FR solution, combining mineral PIN FRs with a ceramifier (glass agent), generates char which retains integrity at 600°C, resists temperatures up to 1000°C and limits heat transmission. It has been developed by Nabaltec with specific in-house testing, including ash bending and ash strength tests, 20 minute flame resistance and temperature at the back of a 3 mm sample. Issues with processability are currently being resolved and a compounding-ready mineral plus glass agent formulation will be commercialised in 2023 for use in polypropylene, polyamide, polyurethane resins and other engineering thermoplastics and thermosets, including glass fibre reinforced, for application in electric vehicle battery housings, electronics and industry.

Mike Bird, Imerys, outlined PIN FR synergist applications of the company's engineered-morphology mineral specialities: talc, kaolins etc. Imerys is the world's leading producer of white industrial minerals. Applications in polymers include for structural reinforcement, dimensional stability, conductivity, rheology and processing modifiers. Specific engineered minerals can provide enhanced fire resistance synergies and smoke density reduction, both by improving char structure and by catalytic functions of certain mineral components. Imerys' current developments include applications for e-mobility based upon polyamide for electric vehicle battery casings, in synergy with phosphinate PIN FRs, improving fire performance (from UL 94 V-1 to V-0 @ 0.4 mm), reducing weight and improving mechanical properties (inc. impact resistance). Processing is also improved because the mineral removes possible acid release from compound decomposition during heating. Another development is use of engineered talc and kaolin in PE-EVA (ethylene-vinyl acetate) in synergy and partial replacement of ATH / MDH, achieving UL 94 V-0 @ 2 mm with reduced peak heat release rate and smoke density.

Michael Suchan, Evonik, presented **developments to implement non-halogenated flame retardants in polyurethane foams**. Companies worldwide are looking to move away from the halogenated FR TCPP (tris(1,3-dichloro-2-propyl)phosphate) to respond to demand for non-halogenated foams for green buildings and to reduce smoke toxicity. This is difficult as alternatives are today powders, and TCPP also has softener properties. Evonik provides additives, such as catalysts, as well as foam stabilisers and processing aids. Work is underway to address problems posed by suspensions of powder PIN FRs, such as shelf-life (deposition), viscosity, foaming nozzle blocking by particles and aggregation in the foam. Dispersion agents are challenging to develop as they must not deteriorate processing (many standard dispersion agents have defoaming properties) and must not increase viscosity. Solutions tend to be polyol and PIN FR specific, working in one foam formulation but not another. The dispersion agent must also function at low doses (< 5% w/w to FR particle) whilst also covering the whole particle surface.



David Stuart, NeoGraf, presented applications of expanded graphite (EXG) as a non-halogenated component of fire safety solution for polymers (see also pinfa Newsletter n°128). New formulations now offer onset temperatures up to 280°C, enabling use in a wide range of polymers including polyamides and ABS. Expanded graphite is used alone to achieve demanding fire performance and low smoke toxicity in train and aircraft seats (in polyurethane foams ???), but is most effective in synergy with PIN flame retardants, such as mineral hydroxides which render char glassy to reflecting heat, or phosphorus which can generate more durable char. Delivery in masterbatches (up to 50% EXG) or polymer-coated particles (0.1% w/w polymer/particle), with various polymers and resins, facilitates handling and processing, ensures polymer compatibility and avoids risks of corrosion, which can result from residual sulphuric acid in EXG (from production).

Darya Zeini, Bioenvision (previously Funzianano), presented R&D developments for silicon-containing POSS FR synergists (polyhedral oligomeric silsesquioxane), see pinfa Newsletters n°134 and 124. These are used as synergists (at < 1% loading) to improve char quality (silicon ceramification), accelerate char formation and increase ignition time. The organic group on POSS enables tailoring for specific polymer, either as reactive or additive. In addition to demonstrated use in polyurethane foams and thermoplastics (such as polypropylene), recent trials have shown effectiveness in acrylic adhesives. More tests are in progress together to investigate the effectiveness in epoxy resins.

COMPANY INTERVIEWS:
FRS FOR SPECIALITY MATERIALS

Jean-Jacques Flat, Arkema

Arkema is looking for sustainable FR solutions with positive LCA, including bio-based, to ensure fire safety whilst maintaining material performance. Flame retardants are needed to enable materials innovation with fire safety in response to societal mega-trends: clean mobility, new energy, insulation, ubiquitous electronics and bio-based materials. Flame retardants need to have safe health and environment profiles, but also to show positive Life Cycle Analysis and recyclability. Arkema is looking for FR solutions which are non-blooming to avoid possible leaching of FRs from products, such as polymeric FRs. A developing demand is for FRs for bio-based polymers, or FRs produced by biological processes. Arkema promotes open research and cooperation to address challenges such as recycling, Life Cycle Analysis and combining fire safety with materials properties and performance.

Arkema is a world leader in speciality materials, created in 2004 from Total's Chemicals branch, with today 20 000 staff and 150 production plants in 55 countries. Arkema builds on science for innovative materials for a sustainable world. https://www.arkema.com/global/en/

Angelo Bottaro, Erdal Karaagac, Gabriel-Chemie

For Gabriel-Chemie, halogen-free is part of the company's sustainability priorities, so avoiding problem chemicals which can hinder recycling. PIN FRs can ensure fire safety and achieve fire performance standards in demanding applications such as stadium seating (colour, UV and weathering requirements, as well as demanding fires safety standards), E&E and construction materials (CPR). ATO (antimony trioxide) in particular is considered an obstacle to recycling because of health and environment questions. A new development from Gabriel-Chemie is a halogen-free masterbatch for electrical conduits, enabling compliance to FR norm EN 61386, to Low Smoke IEC 61304-2 and to Halogen Free standard EN 50642. The company underlines the importance of active cooperation with end-user customers and FR and polymer producers to develop new solutions.

Gabriel-Chemie, founded 1956, is an Austrian specialist masterbatch producer with nine production sites across Europe and over 500 employees. The company develops and produces masterbatches with flame retardants, fillers, antistatic, UV stabilisers, colours, processing and performance additives, in particular for polyolefins and polystyrenes. Services also include formulation advice, technical support and laboratory testing. The company is world leader in stadium seat FR masterbatches. See also pinfa Newsletter n°109 and n°88. www.gabriel-chemie.com

Peter Kornas, BÜFA

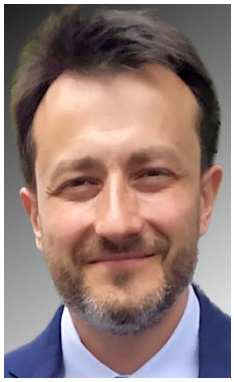
BÜFA is specialised in high performance flame retardant solutions, mainly using PIN FRs for reasons of sustainability. Railway applications see strong growth, with demanding requirements for fire resistance and technical performance, and necessarily PIN flame retardant solutions to achieve low smoke – low toxicity. Current PIN FR solutions readily achieve UL 94 V-0 and EN 45545 railway smoke Class 2, but economic solutions for Class 1 or 0 are not available, in particular for liquid, transparent PIN FRs. Water uptake is also a challenge. BÜFA offers lightweight foams based on unsaturated polyester resins, with PIN FRs included into the resin. BÜFA also offers a range of gelcoat PIN FR fire protection solutions, for application to polymers. The innovative one-layer powder-based process enables inclusion of PIN FR, colour and finishing in a single, smooth, clear coating, avoiding grinding and optimising application (materials saving), without emissions during application and without impacting polymer impact performance properties. BÜFA is continuing to look for innovative PIN FR solutions which can simultaneously address ignition, heat release and smoke emission.

BÜFA, established in 1883, is a family-owned SME specialised in chemicals, cleaning products and flame retardant solutions (FR resins, gelcoats: around one third of company turnover). BÜFA supplies in-house developed FR solutions, especially to the automotive, rail, commercial vehicle, energy and construction sectors, with a main focus on non-halogen systems. See also pinfa Newsletters n°124 and n°98. https://buefa-composites.com/

Diego Tirelli, Lucia Campanelli, Nuova Sima

Mineral PIN FRs are offering increasing fire performance and loading efficiency with new synergists and specialist mineral solutions for applications such as cables, insulation panels, technical rubbers, roofing membranes. Trace minerals in natural ATH and MDH include silicates which can glassify char, improving fire retardancy. Natural MDH and ATH generate char with less tendency to fall away during combustion, so enabling achievement of demanding CPR (Construction Products Regulation) fire tests. Mineral PIN FRs can act in synergy with other additives, for example nanoclays and phosphorus-based FRs. Natural MDH can also provide a competitive PIN FR solution for high melting temperature polymers, such as polypropylene. Nuova Sima is looking to cooperate with PIN FR and synergist producers and with compounders to develop new performance mineral FR packages.

Nuova Sima has been producing since 1965 engineered calcium and magnesium minerals for plastics, rubbers and paints. The company was the first in the world to produce MDH from natural mined brucite and today also produces natural mined ATH, as well as milled synthetic ATH. Nuova Sima has a capacity of 70 000 t/y of speciality minerals from production site in Italy. https://nuovasima.it/en/



Filip Kondratowicz, Synthos

Environment and recycling are key for new products at Synthos and non-halogenated FR for polystyrene is under development. The company led innovation in polymeric brominated FRs now seven years ago and is today advancing towards a halogen free FR solution which maintains EPS (expanded polystyrene) insulation and mechanical properties, offers thermal stability in processing and is self-extinguishing. This will respond to tightening requirements on building insulation fire safety and smoke requirements. Synthos is also looking for solutions to recycling recovered EPS and XPS insulations from building deconstruction and renovation. Contamination with other building materials or demolition dusts prevent mechanical recycling. Solutions are needed to remove problematic brominated FRs such as HBCD in particular.

Synthos is a global chemicals company, established in 1945 in Oswiecim, Poland, with today 3 600 employees and 5 production sites across Europe distributing worldwide. The company is the leading producer of EPS (expanded polystyrene) in Europe, a leading producer of and the second product of synthetic rubber globally, including butadiene rubber for tyres. https://www.synthosgroup.com/en/

Lola Guerra, Lubrizol

Sustainability is a key driver for polymer and FR development today, including safety for health in final use and in processing, LCA, recyclability. Lubrizol is also furthering bio-based materials. At the same time, material performance remains essential and FRs must achieve fire safety whilst maintaining material properties and functionalities. Lubrizol particularly looks to ensure that FR solutions are non-leaching and are compatible with material durability, providing lasting fire performance. More sustainable flame retardant solutions often require a combination of several PIN FRs and synergists. Non-migrating, safe for health PIN FRs will often mean moving to polymeric or reactive chemicals.

The Lubrizol Corporation, a Berkshire Hathaway company, is a global specialty chemicals company founded in 1928 with more than 55 years of polymer experience, approx. 8600 staff and over one hundred manufacturing facilities, sales and technical offices worldwide. Lubrizol Engineered Polymers offers a range of performance TPU (thermoplastic polyurethane) resins and compounds including flame retardant, chemically resistant, bio-based, light stable, adhesive conductive, high thermoplasticity, high strength, impact resistant…. www.lubrizol.com/Engineered-Polymers

Daniele Frasca, Lehmann&Voss

Halogen-free flame retardants are developing extensively and innovative PIN FR systems enable applications in many industries, such as the construction and automotive sectors. This responds to increasing demand for low smoke, which is a requirement in many applications. Customers are increasingly looking for new additives for new polymer applications. For some time, Lehmann&Voss has been working on halogen-free flame retardants for transparent applications in polyesters. Customers often require a UL 94 V-0 classification with reasonable loading and a high limiting index oxygen (LOI). Lehmann&Voss has developed a new formulation with a reactive component: the higher degree of reaction delivers higher performances. In addition, many customers are looking for intumescent systems for polyolefins. Lehmann&Voss provides a formulation which generates an effective protective layer between fire and polymer, and shows higher thermal and UV stability and reduced water absorption.

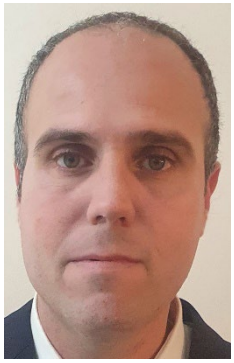
Lehmann&Voss&Co. was established in 1894 as a trading company in Hamburg and is today a trader and distributor of chemical additives and a producer of masterbatches and compounds, with more than 20 years of experience in developing and supplying non-halogenated flame-retardant masterbatches for customers in different applications. Lehmann&Voss&Co with its subsidiaries (LEHVOSS Group) has nearly 600 staff worldwide. www.lehvoss.de

COMPANY INTERVIEWS:
COMPOUNDING TO MATERIAL REQUIREMENTS

Giulia Spezzati, Avient

Avient is responding to customers' wishes to move 100% halogen-free and is developing new PIN FR solutions to combine this with performance. Sustainability is a key objective, essential to customers' futures, and non-halogenated fire safety must be combined with performance and price competitiveness. Avient has developed a new nitrogen-based PIN FR solution for the building industry, which offers performance at a competitive price, complying with sector regulations. PIN flame retardants must be compatible with recycling, and Avient sees strong development in resins based on post-consumer recyclates, requiring a rethink of additives and formulation to achieve performance and quality.

Avient Corporation (Pinfa member) was formed in 2020 when PolyOne acquired Clariant Masterbatch, combining decades of materials leadership. Avient recently acquired Dyneema from DSM, mobilizing 8 400 people worldwide for innovation in specialized and sustainable materials solutions. Avient's products can offer different functionalities, including colour and flame retardancy, for all industry sectors, including polyolefins, styrenics, and engineered polymers. www.avient.com



Doron Sorek, Kafrit

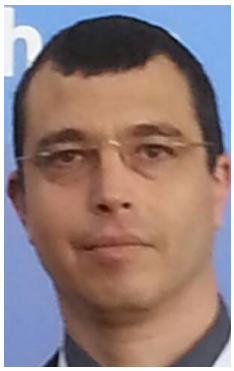
Developments of new products and research are today centred on non-halogenated FR solutions, e.g. for construction, transport, textiles. Kafrit provides highly tailor-made compounds and masterbatches for customers' different applications and performance requirements, including Kafrit in-house additive molecules. Regulation is a challenge to innovation and registration costs are an obstacle to new raw materials, and customers demand full legislation documentation. Customers today want compatibility with recycling, in particular internal recycling of production off-products, and this requires specific expertise for phosphorus and nitrogen FRs because of challenges with dosing, ventilation and reprocessing conditions. Cooperation with PIN flame retardant providers can ensure optimal formulation of PIN FR compounds and expert support onsite for customers to achieve quality and homogenous processing. Masterbatches can also provide compact, low water solutions for easier handling and processing.

Kafrit is a masterbatcher and compounder, established in 1973, with seven production plants across the world, total capacity of 130 000 t/y, and 550 staff. The company develops and supplies compounds of different polymers, including polyolefins, styrenics, polyurethanes, polyamides, polypropylene, polystyrene, polyethylene, polycarbonate for sectors including e.g. packaging agriculture, construction, electronics, transport, textiles. https://kafritgroup.com/

Pascal Wolfer, Lapp Engineering AG

We focus on halogen-free and low-halogen because PIN FRs can achieve fire safety and performance specifications more sustainably. Customised masterbatches enable customers to adapt formulations precisely to specific needs, case by case. Flame retardant levels can be adjusted to achieve fire performance specifications according to different component wall thickness, so optimising both other properties and cost. Lapp Engineering AG sees increasing need for PIN flame retardant solutions for electronics and electrical equipment, with new technology developments. Another developing need is for PIN FR materials for installations for logistics sites (building materials, cables, conduits, installations and equipment …) for which insurers are increasingly requiring fire safety. Another challenge is to find PIN FR solutions for polypropylene copolymer foils for greenhouses, where heat and various electrical installations make fire safety important, compatible with reliable processing of very thin films in large sheets.

Lapp Engineering AG, Switzerland, develops tailor-made polymer masterbatches and compounds since 2004, from compound design, testing and prototyping, through to material supply for production. The company provides masterbatches and compounds for a range of polymers including polyolefins, TPUs, PC-ABS. Lapp Engineering AG products are exclusively available through the distribution partner XINOMER AG www.lappengineering.com



Boaz Turner, Tosaf

Tosaf focuses mainly on gas phase FR solutions which minimally deteriorate polymer performance because of low required loadings. Further development goals are to increase the thermal stability of such flame retardants and adjust the product to the working temperatures range of the manufacturing process, while at the same time optimising cost efficiency. Tosaf sees rapid growth in the FR industry, because fire regulations are becoming stricter, are being extended globally and applied in a wide range of sectors. Green demands and environmental regulations are driving a trend towards halogen-free and antimony-free flame-retardant solutions. Another trend is the growth of the electric vehicles industry, switching more and more parts into plastic and challenging mechanical properties. The rising demand for flame retardants has led Tosaf to establish a new FR factory, with a state-of-the-art lab, to develop the entire range of solutions from transparent films to foams and injected / extruded parts for construction and the white goods sectors.

For over three decades, Tosaf has been developing and manufacturing high-quality additives, compounds, and color masterbatches for the plastics industry. Tosaf services customers in over 50 countries in Europe, North America, South America, Asia and the Middle East, Tosaf has over 1400 employees spread throughout its production sites, warehouses, sales and distribution offices around the world. Tosaf CEO Amos Megides established the company in Israel in 1986, and still stands at its head. Tosaf's major shareholders include: Megides Holdings Ltd. and the Ravago Group.See pinfa Newsletter n° 129 and n° 76 www.tosaf.com

Simone Lotteria, Sirmax

Sustainability is a key objective for Sirmax and its customers, moving away from halogenated FRs, with demand for non-halogen recycled compounds, in particular pre-consumer recycled polyamides, polystyrene, polycarbonate and blends but also post-consumer polyolefins. Flame retardant solutions should offer environment and health safety and be compatible with recycling of the final compound, which requires resistance to reprocessing and compatibility with different additives in secondary material streams. Markets are evolving, for example with connectivity of things, resulting in changing material requirements, for example electrical resistance specifications (CTI, dielectric strength). Synergies between PIN FRs can achieve performance objectives but more complex formulations tend to result in higher costs. Sirmax' experience with different FR solutions and different suppliers enables to offer flexibility and to respond to new customer needs. A challenge is availability of post-consumer engineering polymers to respond to demand for materials with recycled content.

Sirmax is a multi-product and multi-country compounder founded in 1964, with headquarters in Cittadella, Italy, with today nearly one thousand staff in thirteen plants worldwide, producing some 300 000 t/y of polyolefin, thermoplastic, engineering plastic, recycled and bio-based compounds. Sirmax is the 1st non-integrated polypropylene compounder in Europe and the 5th in the world. The company covers a wide range of markets including automotive, consumer appliances, E&E, industry, building, furniture, sport and leisure. www.sirmax.com

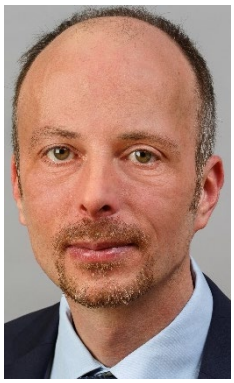
CONFERENCE SUMMARY
RESEARCH INTO PIN FRS

Bernhard Schartel, Bundesanstalt für Materialforschung und –prüfung (BAM), Germany discussed **durability of non-halogenated flame retardancy in E&E plastics**. Stability of flame retarded polymeric materials in some applications, such as outdoor furniture, is today a "solved problem" with recognised solutions available (*pinfa note: e.g. see below interview with Gabriel-Chemie*). Recent publications (Tan et al. 2000 – 1 and 2000 – 2, summarised in pinfa Newsletters n°112 and 125) of accelerated ageing tests of EVA (ethylene-vinyl acetate) cables with different PIN FRs (ATH, MDH, aluminium diethylphosphinate (AlPi), intumescent) suggest that weathering for several years does not significantly reduce fire performance. Further studies by SKZ and BAM were presented (Schloch et al. 2021, not publicly available, abstract here), with different artificial accelerated weathering conditions, simulating harsh conditions and longer weathering times, covering a range of mineral and phosphorus FRs with different synergists in EVA/PE, TPU and PA66-GF. Comprehensive investigations of the ageing of the polymeric materials (all stabilised to the state of the art) followed by different fire tests demonstrates that the degradation occurs quite specifically in terms of weathering condition, polymer, and property. Accumulation of the PIN FR near the polymer surface can in fact improve fire performance with time. Massive deterioration of colour and surface properties and of mechanical properties are noted with time, but mostly no or only moderate deterioration in fire performance, except for an increase of melting-dripping in some fire tests. These effects generally are related to polymer degradation with ageing, not to PIN FRs. Covering a wide range of materials, the studies show that in general the degradation of the polymeric material occurs before the loss of flame retardancy.

José-Marie Lopez Cuesta, IMT Mines Alès, France, presented **laboratory tests of HOLCIM SuperPozz (a refined mineral from coal-combustion fly ash) in PIN FR bio-based polymers PLA, PBAT, PBS** (polylactic acid, poly butylene succinate, poly butylene adipate Terephthalate) with APP or MPP (ammonium- or melamine polyphosphate). SuperPozz is produced by refining fine particles from coal-burning fly ash, and can be used to replace Pozzolan, a mined mineral, to reduce the density of cement products. It is principally mullite (an aluminium silicate mineral), associated with other minerals (see Saker et al. 2018). Tests looked at replacing up to half of the PIN FR (APP or MPP) in 25% loading PIN FR in polymer compounds. Peak Heat Release Rate was significantly reduced using a combination of SuperPozz and PIN FR. Given the low density of SuperPozz, implications on polymer mechanical properties need to be investigated, and increased transport costs must be considered. The safety of the trace minerals present should be assessed. Tests have also been carried out in EVA and in polyamide 6, with good results in the polyamide.

Henri Vahabi, University of Lorraine, summarised laboratory tests looking at possibilities for **PIN flame-retarding natural fibres (flax).** Firstly, to develop non-halogenated flame retardant, electrically conductive natural fibres, flax fibres were soaked in acid, then for two cycles in solutions of sodium polyacrylate, polyethyleneimine (PEI), ammonium polyphosphate and poly(aniline-co-melamine). This resulted in layer-by-layer deposit of phosphorus and nitrogen compounds into the fibre, giving an electrically-conductive, self-extinguishing textile when woven (vertical flame test). The conductivity resisted 30 seconds under flame application. Secondly, to develop a bio-based phosphorus PIN flame retardant for natural fibres, phytic acid (a natural molecule, widely present in plant seeds, and non-digestible by mono-gastric animals such as humans, chickens, pigs) was applied to flax using PEI, resulting in 3.4% phosphorus w/w in the fibre. Peak heat release rate was reduced by a factor of around four, but the treated flax showed greater elongation and lower resistance to break.

Günter Beyer, Fire & Polymer, summarised some developments in PIN flame retardants, based on a literature review of 2021 – 2022. As examples, he summarised two recent studies of non-halogenated FR formulations. Paszkiewicz et al. 2021 tested halloysite nanotubes (HNT) and nano silane surface-treated ATH (ATH-sil from Nabaltec) as synergists to non surface-treated ATH (from Nabaltec) in EVA/LDPE injection moulded 0.8 mm thick samples. Halloysite is a natural mineral, a form of kaolinite, an aluminium silicate containing traces of other metals such as titanium, iron, nickel. 4 -12% of HNT and/or ATH-sil were tested with 48 – 60% standard ATH. This study concludes that these nano-synergists improve the thermal stability of the polymer compound and increase the LOI (limiting oxygen index). Heinz et al. 2021 tested maleic-acid-anhydrite grafted LLDPE as a coupling agent in EVA/LDPE blends with 30 – 60 % loading of MDH (PIN mineral FR, Huber), again injection moulded to samples. This study suggests that the coupling agent improves the dispersion of the mineral FR and the thermo-mechanical material properties.



Elke Metzsch Zilligen & Roland Klein, Fraunhofer LBF, discussed **bio-sourced PIN flame retardants, including bio-based oxyimides, lignin and cellulose based, and also combination of bio-sourced polymers with PIN FRs**. Partially bio-based oxyimides containing an ON(C=O)2 unit which can release flame-quenching radicals in fire and can also be reacted with sulphur or other elements. The biological polymers lignin and cellulose are widely available in wood, paper and other industry by-products and can contribute to char formation. Hydroxyl groups mean than phosphorus can be reacted into these bio-molecules to produce polymeric PIN FRs which have shown to be effective in polyamide, ABS and other polymers. Partially bio-based FRs can also be produced by using bio-based platform chemicals (such as succinic acid, itaconic acid, propane diol, butane diol) or substances which can be produced from renewable resources in future (such as acrylics or pentaerythritol) in the production of standard organo-phosphorus PIN FRs such as DOPO derivatives. Availability of lignin and cellulose are considerably greater than today's total PIN FR production and the production of bio-based platform chemicals will grow to fulfil future requirements.

AMI Fire Retardants in Plastics (USA) 2023,
26-27 April 2023, Philadelphia
www.ami.ltd/event-fire-USA

Flame Resistance in Plastics (Europe) 2023
20 - 22 November 2023 www.ami.ltd/event-fire
Westin Grand Hotel, Berlin**, Germany**

AMI conferences: https://www.ami.international/events

AMI | Events
Fire Retardants in Plastics

PUBLISHER INFORMATION

This Newsletter is published for the interest of user industries, stakeholders and the public by pinfa (Phosphorus Inorganic and Nitrogen Flame Retardants Association), a sector group of Cefic (European Chemical Industry federation) www.pinfa.org. The content is accurate to the best of our knowledge, but is provided for information only and constitutes neither a technical recommendation nor an official position of pinfa, Cefic or pinfa member companies.

For abbreviations see: www.pinfa.org