Your newsletter for non-halogen fire safety solutions
No. 61 – special February 2016 - AMI Fire Resistance in Plastics

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FR technologies and social acceptance

Over 300 experts in industrial plastics and in plastics fire safety met in Cologne, Germany, at the **10th AMI conference on "Fire Resistance in Plastics"** to discuss developments in flame retardant technologies and applications in plastics, regulations and testing and challenges to flame retardant chemical acceptance and use. Participants were from 23 countries worldwide and represented industries including polymers, compounding, flame retardants, cables manufacturers, electrical and electronics equipment producers, timber protection and R&D.

Conference proceedings: http://www.amiplastics.com

Upcoming AMI polymer flame retardancy conferences:

- USA: 3-4 May 2016, Pittsburgh Pennsylvania
- Europe: 6-8 Dec 2016, Cologne, Germany

https://www.amiplastics.com

Photos: courtesy AMI Ltd.

Noru Tsalic, AMI (Applied Market Information), opened the conference with the challenge of "The next frontiers in fire retardancy markets", questioning how industry can re-establish the legitimacy of flame retardants as essential for protecting human lives. In 2013, fires caused over 3 000 deaths and nearly 16 000 injuries in the USA, despite reductions in smoking and installation of smoke alarms, so it is not an issue society can dismiss. Regulation is necessary and justified. In developing countries, the problem is much greater, with e.g. over 60 000 fire deaths per year in India alone. Mr Tsalic concludes that the flame retardant industry's two frontiers for coming years are to convince the public to desire fire safety and recognise flame retardants as an essential part of this and to take fire safety to developing countries, to save lives, by fire safety regulation in these countries and importantly its implementation

Future fire safety solutions

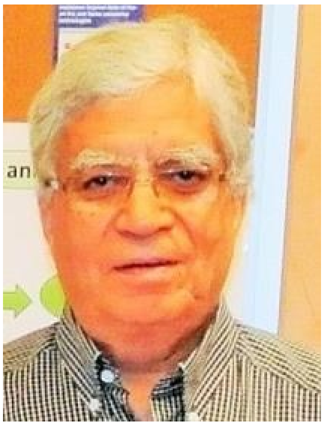
AMI (Applied Market Information)

The perfect flame retardant cannot exist

Noru Tsalic, *outlined the characteristics of the ideal flame retardant chemical:*

- *No environmental or health impacts in production, use, fire or end-of-life. Zero is not possible, particularly as FRs are designed to be durable to ensure fire protection throughout products' life. Furthermore, society increasingly considers that a possible risk is a real problem, but perception should not be allowed to trump science*
- *Not deteriorate polymer performance. This is difficult as FRs often necessitate high loadings.*
- *Compatibility with polymer processing. Challenging because FRs are designed to decompose in heat.*
- *Low cost. But this is contradicted by increasing environment and health regulations and testing requirements, which are expensive for chemicals producers.*

Industry therefore needs to clearly state that the perfect flame retardant cannot exist but to show that it is genuinely engaged to improve fire safety chemicals, based on science. On the other hand, the general public is increasingly safety conscious, as was shown by the public demonstrations in Romania following the Collectiv nightclub fire, Bucharest (see pinfa Newsletter n°58). The challenge for industry is to convince that flame retardants are necessary for fire safety which is desirable for society. Modern, cost-effective, internet communications tools make this feasible with limited budgets.



Bansi Kaul, MCA Technologies, presented his view on industrial priorities for PIN flame retardant development:

- Reduced PIN FR loadings, whilst ensuring fire safety, because high loadings are contrary to the objective of plastics of reducing weight. This will result in a continuing push to develop new, high-performance organic PIN FRs
- Compatibility with colour finish flexibility
- Flexibility for use with different polymers, different properties.

His company's MCA-PPM-triazine, an organic phosphorus-nitrogen compound can act as an effective, water resistant, synergist with different inorganic PIN FRs and organic intumescent PIN FRs in a wide range of polymers. The product acts by improving char coverage (avoiding cracks in char which enable flames to contact with polymer).

MCA Technologies
Improving regulations to improve FR use

***Bansi Kaul** considers that regulations need to be improved in different areas related to both flame retardant products and to fire safety. **Reducing smoke emissions**: flame retardants are often used at just the minimum dose needed to pass applicable fire tests. This can result in smoke emissions, as the product "nearly burns". Better regulation should widen smoke emission testing and limit smoke emissions. Halogenated flame retardants mostly act on the flame in fire, so with smoke emission, whereas PIN FRs which generate char will mostly reduce smoke emission, both be preventing flame contact with the polymer and by trapping smoke and soot particles in the char. **Testing and limiting levels of flame retardant migration** out of polymers, both in product use and also in recycling or reprocessing. **End-of-life**: recycling of plastics is in many cases not possible, because the polymers deteriorate and lose properties with ageing, so downcycling, breakdown to fuels or incineration will be necessary. This should be taken into account in flame retardant regulation.*

Klaus Rathburger, George H. Luh GmbH, presented applications of expandable graphite as a high-performance PIN FR component in applications including textile fire safety, metal fire protection and fire seals (in cable voids, around doors). Expandable graphite consists of multiple mono-atomic layers of graphite (graphene), to which an acid and an oxidising agent are added so that if heated (to c. 200°C) the layers of graphene expand apart, increasing volume by 200 – 300 times. This generates a thick intumescent layer, which can insulate against heat (structural protection) and inhibit burning (flame retardancy), and can also reduce smoke emissions by up to 50%. The use of organic acids (e.g. acetic acid, instead of the more generally used sulphuric acid) can avoid acidity in fire from sulphur release.

George H. Luh GmbH
Customers want new solutions

***Klaus Rathburger**, sees a continuing movement by customers towards non-halogenated flame retardants. They are not stepping back from flame retardants, because fire safety continues to be demanded both by regulation and by product manufacturers. However, they are looking for new, alternative solutions, with performance packages of PIN flame retardants and synergists with specific functions for different polymers.*

VELOX
Strong development in PIN FR markets

***Claudia Fath, VELOX**, a world leader in plastic additive distribution and marketing, outlined for the pinfa Newsletter the trends she sees in flame retardancy. The FR market is driven by regulation, and the new CPR (Construction Products Regulation) and railway standards (EN 45545) in Europe oblige to achieve lower heat release and lower smoke emissions, which PIN flame retardants can ensure. Polymer producers, compounders and equipment manufacturers are looking for "greener" solutions which are cost-effective and efficient. Strong development can be expected in various PIN FR markets. Clays offer interesting properties in improving char characteristics, in synergy with other PIN FRs, and can be naturally sourced (processed mined minerals). Polymeric phosphorus FRs (such as FRX Nofia® see pinfa Newsletter 57) can offer high performance (maintain polymer properties) and good health and environmental profiles. Training of compounders is essential, because the application concept of polymer PIN FRs is not like traditional additives. Challenges for PIN FR development include addressing the dilemma of combining durability (long-lasting product performance and recycling potential) with biodegradability and non-persistence in the environment.*

SILMA
Fire safety, health safety and recycling

***Camillo Cardelli, SILMA Masterbatches**, takes home from the conference that tomorrows flame retardants must be "green", combing fire safety performance, environment and health safety and full polymer recycling: the Circular Economy is crucial. To achieve these objectives, and to reduce possible toxicity of smoke and soot, industry must aim to remove halogens and heavy metals. Mineral and phosphorus compound PIN flame retardants and fillers offer this potential. The SILMAFLAME range of PIN flame retardant Masterbatches is already working in these directions, including products for polypropylene (UL94-V0 or Class B1 DIN4102) and for polyethylene films (replacing legacy FRs at the same dosage to offer high mechanical performance and light stability in thin films).*

NILIT Plastics Europe
E-mobility and miniaturisation will bring new fire resistance demands

***Holger Brandt, Nilit Plastics**, sees new flame retardancy needs in developing markets such as electric vehicles and mobile and miniaturised electronics, but also in response to safety objectives for household E&E goods. Requirements are increasingly demanding: thin wall structural and fire performance, high temperature stability and processability are all essential for miniaturisation. At the same time, trends towards sustainability and environmental assessments make PIN fire safety solutions essential. There is huge potential for new PIN fire safety solutions for FR engineering plastics, particularly for organic phosphorus flame retardants. Nilit's FRIANYL XT non-halogenated FR PPA family (Performance PolyAmide), see press release and pinfa Newsletter 53) follows these trends and offers a solution with UL94-V0 down to 0.4 mm for all colours withstanding elevated temperatures during processing and final use and compliant with all relevant European environmental standards..*

Circular Economy

Lein Tange, ICL-IP and EFRA, explained the importance of the Circular Economy for the sustainability of the flame retardant industry. Flame retardants will increasingly need to be compatible with recycling. This is pushed by standards such as IEC111 and TC111x material resource efficiency standards, EcoDesign requirements (which are a key element of the European Commission's Circular Economy Package, published 2/12/2015), and by objectives fixed by sustainability policies of equipment manufacturers (OEMs) and plastics user industries. The Circular Economy will also push for increasing use of bio-based polymers and flame retardants. These objectives are coherent with the stewardship programme VECAP developed by industry which has shown considerable success in limiting emissions during manufacture and downstream application (compounding, polymer use) and in avoiding uncontrolled landfill.

ICL-IP
Flame retardants must be designed for recycling

Lein Tange *underlines the contradictions between plastics recycling and the today's tendencies to miniaturisation and specialisation in electronics and other equipment, with increasingly complex and varied combinations of polymers and additives. Also, the push for non-persistent flame retardants is contradictory to producing chemicals which are sufficiently resilient to resist re-processing in recycling. Above all, recycling requires a long term vision of flame retardant products: it is important that today's alternative FR does not become tomorrow's problem in recycling.*

Deflamo
Future proofing flame retardants

Mats Ericson, Deflamo *takes home from the AMI Cologne conference the drive for non-toxic, sustainable fire safety solutions. Smoke toxicity is key for fire safety, but is missing in many fire standards at present. Chemical reactions in uncontrolled fire are complex and variable, but non toxic flame retardants are a step in the right direction. Flame retardant systems must also anticipate future demands for material recyclability, especially systems for plastics, and also provide solutions for increasing application of bioplastics. It is important to be proactive and develop products which combine environmental safety with fire safety, now, to anticipate future legislation and demands. Deflamo see pinfa Newsletter n°10.*

New, high performance, PIN FR products and processes

Viggy Mehta, Polymer Dynamix, presented the company's silicone based DynaSil™ FR synergist which is effective with PIN flame retardants such as metal hydrates, metal phosphinates, and other phosphorous nitrogen based FRs. The products can also be used to reduce or eliminate antimony trioxide in tradition halogen FR systems. DynaSil™ offers the advantage of behaving like a liquid under shear which leads to improved polymer flow during compounding and post extrusion or injection molding. During a fire, the liquid-like nature of DynaSil™ leads to rapid formation of a crack-free ceramic char layer which reflects the heat during a fire and reduces smoke and flame spread during a fire and can also prevent re-ignition during multiple flame applications in a fire test. In other conditions, the material acts like a solid which does not bloom or migrate. DynaSil™ offers a good environmental profile and very low toxicity.

Vincent Rerat, Dow Corning Europe, outlined challenges for performance flame retardants in transparent polycarbonates, which are increasingly in demand for specialist applications in electronics (e.g. screens), transport and architecture (e.g. sky domes). The company's specialist silicones provide efficient synergists for PIN flame retardants. In fire, with KSS (Potassium Diphenylsulfone Sulfonate) or HES (Complex sulfonate salt blend), they react with the polycarbonate polymer to accentuate char formation. They also offer transparency, good dispersion and improve flow, so facilitating production of complex and thin-walled components, and enabling mechanical performance to be maintained by adjusting the polycarbonate grade. UL94-V0 at 1mm and EN 445/545 railway standards can be achieved, with a 50% reduction in smoke (probably because the porous char formed dampens and adsorbs fumes). These silicones are short, linear polymers (without Si_5 rings) and so are not persistent, and are recognised as safe (used in cosmetics).

Peter Gohl, Farrel Pomini, presented performance compounding equipment offered by his company. Innovative screw design and control systems ensure low shear forces, low mixing temperature increases, and high flexibility continuous operation. This makes possible the production of high loaded compounds with good mixing and reliability (e.g. over 85% inorganic flame retardants in EVA / LDPE). The units can achieve mixing with a residence time of 20 seconds and temperatures up to 240°C, enabling high productivity.

Andrea Castrovinci, SUPSI Switzerland, presented development of a scaled-down SBI-type testing apparatus, permitting screening fire tests of panel materials. The design is similar to the full-scale SBI (Single Burning Item) test, which uses 2.25 m^2 of material set up as a room corner. The scaled-down version uses 0.375 m^2 in a similar set up, but in an enclosure which can be installed into a standard cone calorimeter test apparatus.

Jean-Marie Maldijan, Schneider Electric, explained the importance of fire resistance in electrical components, such as switches, plugs and circuit breakers. Electrical connections can deteriorate because of wear of contacts, loosening of wire screws, incorrect installation or damage or simply by corrosion of contacts, resulting in resistance which can cause very high local temperatures when current flows. Such electrical parts are often situated very close to larger flammable items (such as casings or internal parts in consumer white goods) so a small fire in the polymer in e.g. a switch can spread rapidly. These parts can be made of either thermoplastics or thermosets. Fire testing is by either UL94 or the GWFI (Glow Wire Flammability Index). GWFI pass can be achieved by polymers which melt away from the applied glow wire. Intumescent PIN flame retardants can ensure fire safety and pass both tests, and PIN systems generating ceramic-based char layers are preferable because carbon-based or graphite char is generally not electrically insulating.

Franck Gyppaz, Nexans, presented the company's range of cable PIN fire performance solutions including ceramifiable INFIT™. These generate a crack-free protection around the cable conductor core in fire which ensures electrical insulation. Nexans fire-rated cable solutions combine polyolefins, fillers and specific PIN additives in sheath – bedding – insulator systems to ensure cable flexibility during installation, maintenance of properties with ageing, electrical resistance and fire performance with low smoke – zero halogen (LSZH). Developments in cable fire testing, intended to ensure that cable fire safety is increasingly representative of real-life fire dangers, include the introduction of CPR (Construction Products Regulation), with harmonised and demanding cable fire standards, applicable to unprotected cables and associated cable management systems (duct, tray, ladders...) and to standard cables in protective systems. The new European fire standards EN50577 requires fire testing of the cable at its rated operational voltage. This can imply testing at significantly higher voltages than in the past, so is much more demanding regarding maintenance of electrical insulation.

Nexans
PIN FRs to meet cable fire safety challenges

Franck Gyppaz *explained the fire safety challenges for cables. Cables must ensure continuing of function (transmission of electrical current, data) during fire, for significant times, in order to ensure continuing operation of safety installations, alarm systems. This requires maintenance of both continuity and electrical insulation when subject both to fire heat and to mechanical stress, as installations will distort and move in fire. Cables must not propagate fire, as cables often cross walls and other barriers, are present in voids inaccessible to fire fighters and sprinklers. Finally, and importantly, cables must ensure low smoke emissions and low fire gas toxicity (Low Smoke Zero Halogen LSZH). Nexans uses PIN flame retardants to ensure these different performance demands.*

Günter Beyer, Kabelwerk EUPEN, summarised challenges in ensuring fire safety of PVC cables. To pass UL910 (Steiner Tunnel, which simulates cables in a void with high air-flow), a combination of FR chemicals is needed in PVC including antimony, halogenated phthalates, inorganics, chlorinated paraffins. Because antimony generates high smoke emissions, zinc or molybdenum compounds are added as smoke suppressors. The molybdenum additives in PVC generate aromatic carbon compounds in soot during fires.

Trelleborg
Sustainable performance in demanding environments

Doug Mart, Market Development Manager for Trelleborg's offshore operations*, says customers want performance and guaranteed safety combined with sustainability. The company's fire and oil resistant rubber-based Firestop™ material technology offers flexibility and resistance to movements and extreme conditions and a very long reliable lifetime. PIN flame retardant solutions withstand jet fires (ISO 22899) with heat flux 390kW/m², temperatures over 1400°C and flame speeds exceeding the speed of sound, and meet USCG (US Coast Guard) fire endurance standard L3 and L3W/D. Such innovative and advanced fire safety solutions contribute to onboard safety and operator and staff peace of mind.*

André Le Gal, Solvay, presented the company's latest innovation in PIN flame retardant polyamides. The recently introduced halogen-free Technyl® One features best-in-class RTI values (150°C at 0.4mm) combined with excellent processing characteristics. High electrical tracking performance (CTI Current Tracking Index 600V) compared to standard brominated FR solutions is crucial to address miniaturization trend. On top of excellent mechanical properties, Technyl® One exhibits low smoke toxicity values which are key for construction and railway applications (EN 45545-2 HL3, ISO 5659-2). Benefits on processing efficiency were demonstrated by an internally developed corrosion test based on injection moulding.

Solvay
Drivers for performance PIN flame retardant solutions

André Le Gal *notes that both the miniaturization in the E&E market (electrical and electronic) and engine downsizing in the automotive industry (in order to meet latest emission standards) have led to a steady increase of thermal constraints on plastic materials. This has fuelled innovation during the past years for polyamide producers and compounders. As a consequence, the landscape of material solutions has been moving from conventional systems to more sophisticated technical approaches addressing specific application requirements. On the other hand, the market pull by large OEM for halogen-free materials is now well established in the E&E industry. This is well in line with R&D efforts within Solvay Polyamides which are exclusively dedicated to the development of non-halogenated solutions, as integral part of the Solway Way framework and the Sustainable Portfolio Management program (http://www.solvay.com/en/sustainability/index.html).*

Sophie Duquesne, ENSCL (National Higher School of Chemistry Lille, France), presented research into different PIN flame retardancy strategies in polyurethane. Additive inorganic PIN flame retardants (APP ammonium polyphosphate + nano magnesium oxide) showed to be effective by producing a consistent char, with magnesium phosphate formation contributing to char effectiveness. A reactive PIN FR package based in siloxanes reacted into the polyurethane polymer showed a 25% reduction in peak heat release rate, with generation of a silicon char fire barrier. Surface coatings are also being investigated, using low-pressure plasma to polymerise monomer substances deposited on the foam surface, but more cost-effective application processes need to be developed for this to be industrially feasible.

Manfred Döring, Fraunhofer LBF, presented development of PIN fire safety solutions for epoxy resins and epoxy resin / carbon fibre composites. Because the carbon in these composites can impact char formation, PIN FRs need to also act in the gas phase to be effective. DOPO-based phosphorus FRs do this by releasing $PO^{\cdot}$ which acts as a radical scavenger in the flame. Fraunhofer, with industrial partners including Dow and DIC, has developed a number of specific DOPO, melamine, polyphosphate and polyphosphazene based solutions offering specific functionalities for expoxies. N-reactive DOPO and bonded DOPO groups (bi-, tri- or polymeric DOPO) can react into the epoxy so avoiding migration and improving moulding homogeneity. Under heat, the bonds between DOPO groups will break preferentially to epoxy bonds, so improving processing temperature and use temperature characteristics.

Alicia Rul, Nanocyl, presented applications of the company's multi-walled carbon nanotubes (MWCNTs) NC7000™ including as a co-synergist additive with other PIN flame retardants. The main applications of the product to date (400 tonnes production 2014) are to impart electrical conductivity or mechanical strength to polymers, including application in lithium-ion batteries. In flame retardancy, the NC7000™ carbon nanotubes increase char production and prevent char cracking, and also appear to trap free radicals (so inhibiting flame) and orientate polymer degradation in fire towards carbonisation (char production) rather than volatisation (flame feeding). The EU-funded DEROCA project (see pinfa Newsletter 60) has shown that the NC7000™ carbon nanotubes enable a reduced filler load of PIN flame retardants in five different applications (e.g. EN50399 Euroclass B2 in cables compared to reference without NC7000™ achieving Euroclass D).

Nanocyl
Health and environmental safety of Nanocyl carbon nanotubes

Nanocyl *is fully aware that there is public and regulatory concern about "nano" materials, because their properties can in some cases be very different from standard forms of chemicals, and the company is addressing this with a proactive policy of health testing and transparency. In compliance with generally accepted OECD guidelines, tests were conducted on intake and absorption via the mouth, skin and respiratory passages. The studies found no indications of a harmful effect from potential exposure under realistic industrial conditions. A 90-day inhalation study was conducted on animals in order to evaluate the potential respiratory impacts of NC7000™ multi-walled carbon nanotubes. The results show lung inflammation similar to any inert powder. This confirms health and safety data from workers in the company's production plant which has now been operating for more than ten years. This positive health profile is coherent with the characteristics of the nanotubes which are short (so not susceptible to physically damage or penetrate cells) and tangled (so not easily absorbed into cells). Also, abrasion studies of polymers containing the nanotubes show that the nanotubes are not released, probably because they are still embedded into the matrix even after strong mechanical stress.*

FR sustainability as corporate policy

Adrian Beard, Clariant, presented the company's "Portfolio Value Programme System" which aims to ensure that its products are positive for the planet (Life Cycle Analysis), for people (responding to social mega-trends and societal needs) and offer good performance (compared to the current market standard). This represents constantly moving targets, driving product improvement. Clariant believes that this is fundamental to the company's markets, because of the need to respond to customers' own sustainability programmes (e.g. electronics manufacturers) and to investor confidence (due diligence and financial risk of environmental liabilities). Clariant is proud to be in the Dow Jones Top 10 sustainability stock listing.

Marc Leifer, ICL, presented the company's SAFR™ methodology, which classifies flame retardants/applications according to a 2-way matrix of hazards (as identified by REACH and GHS, including breakdown products), and exposure to humans and the environment during the use phase. As a structured methodology, SAFR™ provides the entire value chain with an application-oriented tool for flame retardants selection. Reactive flame retardants and polymeric flame retardants offer low leaching (not water extractable), low blooming (no migration into air) and low bioaccumulation potential. ICL's brominated polymeric FRs conform to OECD "polymers of low concern" classification. Although SAFR™ doesn't address specifically stewardship during downstream use, this is covered by the company's VECAP programme.

Tomorrow's flame retardants

Henri Vahabi, Université de Lorraine, France, and PolyFlame Newsletter, presented research into fire performance of PIN FR / acrylic resin / fibreglass thermoplastic composites. Today's aircraft are over 50% by weight composites, enabling weight reduction and so improved fuel efficiency. Thermoplastics offer both lower weight and faster, cheaper production cycles than thermosets, as well as better recycling potential. Appropriate combinations of phosphorus FRs (Exolit® OP930 phosphinate and DOPO = 9,10-dihydro-9-oxy-10-phosphaphenanthrene-10-oxide), inorganic FRs (ATH aluminium trihydroxide) and expandable graphite showed peak heat release rate (PHHR) reduced from over 200 to 80 kW/m^2, close to the objective performance for aircraft applications of 65 kW/m^2.

PolyFlame
Tomorrow's ecological FR solutions will be PIN

Henri Vahabi *considers that the public needs to be educated both about fire safety and about fire safety chemicals. Flame retardants have a long history of making society safer, for example with the use of alum during the siege of Piraeus in 83 BC or Lussac's use of APP (ammonium poly phosphate) to address fire risks in Paris theatres in the nineteenth century. These safe PIN FRs continue to be widely used today. The recent bus fire in the French Pyrenees (pinfa Newsletter 57), in which 43 people were killed by fire and smoke, show how fast and deadly fire can be in modern materials. Why are train passengers protected by demanding material fire safety regulations, but not bus and coach users? At the same time, possible health impacts of FRs must be addressed (as underlined by the recent French ANSES report, pinfa Newsletter 57). Tomorrow's ecological FR solutions will be PIN, with in particular the use of complex phosphorus chemicals such as DOPO, for which toxicology data should be actively developed.*

pinfa
The ongoing quest for safer flame retardants

***Adrian Beard, as Vice-President of pinfa**, presented pinfa's vision of the "ideal flame retardant" – safe, effective in reducing fire dangers, accessible costs, compatible with polymer performance and quality - recognising that this is an ongoing journey with considerable challenges to address. pinfa is reaching out to stakeholders, including FR users, regulators, R&D, NGOs, to take this forward and to define priority areas of action. Considerable progress has been made in improving flame retardant safety over the last 20 years, driven by NGOs, scientists and regulators' concerns about POPs (persistent organic chemicals), indoor air concerns and by flame retardants being found in human bodies or in the environment. This has resulted in a number of flame retardants being regulated: for example 17 FRs restricted under REACH and a further 14 on the 'candidate list" (including brominated FRs, phosphorus containing, inorganic). However, pinfa's objective is to move beyond such 'reactive' positions, led by regulation, and to find tools to identify flame retardants which offer optimal environmental and health profiles. pinfa works with different independent, third-party tools, including the US EPA's alternatives to brominated flame retardants assessments, ecolabels, Green Screen, EU-funded R&D projects (such as ENFIRO, see pinfa Newsletter 36). Ecolabel schemes, such as EPEAT (pinfa Newsletter n° 32) or TCO (n° 54), by excluding some or all halogenated FRs, push to develop preferable alternatives.*

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). 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

Agenda:

Upcoming pinfa events:

26-27 April	Montreal, Canada	►	**pinfa-na industry seminar: flame retardancy of materials for surface transportation** http://pinfa-na.org
15 June	Brussels	►	**pinfa General Assembly**

For complete, up to date events listing, see www.pinfa.org