2008 North American Flame-Retardant Materials

Product Innovation of the Year Award

FRX Polymers

The 2008 Frost & Sullivan North American Product Innovation of the Year Award in flame-retardant materials goes to FRX Polymers, LLP (FRX) in recognition of the company's creation of a new class of novel, high-performance flame-retardant polymers that are used as transparent, high melt flow, non-burning specialty plastics and as polymeric phosphorus-containing Flame Retardant Additives. The company's technology is far reaching in that it facilitates functional improvements in a wide variety of products: electric and electronic devices, household equipment such as television set housings and kitchen appliances and electronic equipment housings (computers, fax machines, cell phones, PDAs, printers, etc) and all types of electrical connectors and internals.

FRX Polymers is a young and upcoming company with offices in Chelmsford Massachusetts. The company is a partnership between Triton Systems, Inc., a private American R&D company, Gadin Technologies and Limburg Technologies. FRX's research and pilot production operations are based in Massachusetts.

FRX was founded with a view to develop and commercialize new types of polyphosphonate homopolymers and copolymers for use as polymeric flame-retardant additives for plastics as well for transparent, high melt flow, non-burning specialty polymers. Many construction or automotive elements, which require transparent non-burning polymers, could be fully replaced by nonflammable, transparent FRX Polymers materials.

It is important to note that the $15 billion global market for flame-retardant polymers is comprised of two major segments: the $11.5 billion flame-retardant plastics compound market and the $3.5 billion flame-retardant additive market. Over 70% of the flame-retardant additives are sold into the plastic industry, and over 75% of the demand in this sector is generated by fast growing electric and electronic markets. FRX Polymers' approach to flame-retardant materials could potentially impact this huge market sector.

FRX Polymers' products, apart from their high flame-retardancy, have other useful features. For example, its materials are halogen-free (an important issue for end-users) with flame retardancy stemming from polyposphonate constituent polymers with a phosphorus concentration of just over 10%. Moreover, in comparison to the other solutions, FRX's fire resistant polymers are also filler free, homogenous, and transparent. In the form of the blends with popular acrylonitrile butadiene styrene (ABS) or polybutylene terephthalate (PBT), FRX polymer's performance provides critical improvements to many competing products on the market.

FRX's materials are primarily polyphosphonate homopolymer and copolymers of polyphosphonate (P-PHOS) with polycarbonate (PC). These products exhibit Limiting Oxygen Index (LOI) values of up to 65%. Moreover, all of these materials are transparent and possess high glass transition temperature, which starts from the level of 105 °C for homopolymers and up to 140 °C for the copolymers. The polymers are also extremely stable with a Thermal Gravimetric Analysis of over 400 °C which allow them to be used as flame retardant additives with high melting plastics such as PBT.

As one of FRX's most valuable innovations, these polymers are produced via the smart polycondensation production technology. This reaction employs Bisphenol A (BPA) as one of the monomers, which reacts with phosphorous-containing ester to generate polyphosphonate in the melt phase. The most important feature of FRX's technology is the similarity of production methods to Polycarbonate. The key difference is that PC is made with diphenyl carbonate (DPC) as a co-monomer with BPA, while P-PHOS uses diphenyl methlylphosphonate (DPP) as the co-monomer with BPA. The company's smart technology allows sequential copolymerization of these two monomers in one reactor. In effect, the resulting copolymer consists of blocks of polycarbonate and blocks of polyphosphonate. Since the P-PHOS and PC polymer chains are connected on a molecular scale, a single glass transition temperature is achieved. The glass transition temperature depends on the relative concentration of PC blocks to P-PHOS blocks. Modification to the concentrations of P-PHOS and PC in the polymer is accomplished by changing the ratio of the monomer streams (DPC, DPP) fed to the reactor. Properties of the copolymer depend almost linearly on the mass ratio of used monomers. However, the products exhibit nearly identical refractive index as PC, which makes FRX Polymers fully transparent. Properties of these polymers can be easy modeled according to customer needs.

The employment of such materials offers a number of practical advantages. In the event of fire, a phosphoric acid char is formed on the surface of the plastic. FRX Polymers' materials exhibit two types of char when exposed to the fire. In the case of the homopolymer (pristine P-PHOS), the char is glassy, clear, and transparent and is the result of condensation of the acids on the plastic parts preventing the oxygen from penetrating into the material or combustible gases from penetrating out. In the case of the copolymer with PC, a crusty carbonaceous char is formed which also blocks oxygen from getting in and combustible gases from getting out. The carbonaceous char also acts to prevent polymer dripping and as a heat transfer shield by decreasing the rate of heat flux penetrating the polymer surface. A key advantage is that while the copolymer incorporates small amounts of phosphorous (less than 10.8 % for the homopolymer), it still exhibits excellent flame-retardant properties. FRX has performed many flame retardancy experiments with its materials. For instance, in cone calorimetry experiments run with a constant heat flux of 30 KW/M2, it took over 5 minutes to ignite the homopolymer. The results of flaming experiments (expressed by LOI), cone calorimetry tests, or various specific trials, such as the well-known UL-94 V0, have confirmed the utility of these new polymers. (Please go to www.frxpolymers.com for a video demonstration of the burning behavior of these new polymers).

One of FRX's goals has been to achieve the thinnest transparent UL 94 V0 rated Polycarbonate grade; they have succeeded in this respect. So far, the thickness of the PC layer meeting the UL 94 V0 while maintaining full transparency requirements was 3 mm. FRX has excelled in developing fully transparent 1.48 mm thick film with a UL94 V0 rating while also improving the melt flow rate. In FR PC/ABS formulations, FRX Polymers was able to match the flame retardancy of competitive products while at the same time improving the final composite's heat distortion temperature to 115 °C and as high as 130 ° (a 25 °C up to 40 °C improvement over the current state of the art formulation). In applications with PBT, a UL 94 V0 was achieved at 0.8mm thickness while also doubling the melt flow rate versus competitive FR PBT grades.

FRX's materials are also distinguished by their high melt strength, enabling them to be used for extrusion and blow molding applications. When compared to liquid-based flame retardants (such as BAPP or RDP), FRX's materials deliver improved heat distortion temperatures and will not migrate out of the host plastic over time, allowing them to deliver long lasting flame-retardant properties. The materials exhibit consistent fire resistance properties during their entire life because the chemicals responsible for fire resistance cannot be rinsed out or eroded. The unique homogenous form of "FRX polymers" materials with controllable flame-retardant properties and high transparency allow them to be applied in many areas such as flame-retardant additives, special flame-retardant polymers, and blow-molded products.

In summary, FRX polymers have earned Frost & Sullivan's Award for Product Innovation of the Year for its efforts in advancing innovation in flame-retardant materials for many demanding technical applications.

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AWARD RECIPIENT

Award Description

The Frost & Sullivan Award for Product Innovation is presented each year to the company that has demonstrated excellence in new products and technologies within their industry. The recipient company has shown innovation by launching a broad line of emerging products and technologies.

Research Methodology

To choose the award recipient, Frost & Sullivan's analyst team tracks innovation in key hi-tech markets. The selection process includes primary participant interviews and extensive primary and secondary research via the bottom-up approach. The analyst team shortlists candidates on the basis of a set of qualitative and quantitative measurements. The analysts also consider the pace of research and technology innovation, and the significance or potential relevance of the innovation to the overall industry. The ultimate award recipient is chosen after a thorough evaluation of this research.

Measurement Criteria

In addition of the methodology described, there are specific criteria used to determine the final rankings. The recipient of this award has excelled based on one or more of the following criteria:

- Significance of new product(s) in their industry
- Competitive advantage of new product(s) in their industry
- Product innovation in terms of unique or revolutionary technology
- Product acceptance in the marketplace
- New product value-added services provided to customers
- Number of competitors with similar product(s)