ELEMENTIS

Fire retardant synergists for the plastics processing industry

Over the past decade, the consumer product and industrial plastic industries have undergone significant changes in the ways that products are produced and certainly in the acceptance of permissible ingredients used in plastics. These shifts have been largely driven by consumer demand for enhanced sustainability, safety and performance in plastics, fueled by the rapid adoption of e-commerce, cloud computing, e-mobility, and the electrification of modern society. Among these changes, the general demand for better fire retardancy and thermal resistance in plastics has surged leading to a strong need for improvements in the effectiveness of the fire retardants used in plastic resins. Performance processing additives such as fire retardant synergists have been crucial in achieving these advancements.

Shifting away from halogenated flame retardants

Halogenated fire retardants, including brominated and chlorinated compounds, have been widely used since the 1970s due to their cost-effectiveness in enhancing fire resistance. However, concerns over their environmental persistence and associated health risks have led to stricter regulations and a growing shift toward safer alternatives. As a result, there is an increasing preference for non-halogenated options, such as phosphorus-based fire retardants, mineral-based retardants like aluminum hydroxide, and intumescent systems. Nevertheless, non-halogenated fire retardants typically require more than double the loading levels of their halogenated counterparts, which highlights the need for synergistic performance additives like CHARGUARD™ to optimize overall formulation performance.

A safer, more sustainable alternative to halogenated flame retardants

As manufacturers move away from halogenated flame retardants that linger in the environment and pose health risks to humans, organoclays are emerging as the synergists of the future. With impressive safety credentials and superior thermal insulation properties, they're ideal for creating higher-performing, more durable products.

Introducing CHARGUARD™ 1000 and CHARGUARD™ 2000 organoclays from Elementis

CHARGUARD™ 1000 and CHARGUARD™ 2000 by Elementis are organically modified clay-based performance additives designed to provide anti-drip and char-promoting functions in non-halogenated fire-retardant systems. These additives are low-polarity aliphatic quat-based organoclays that do not contain intentionally added PFAS ingredients.

These products significantly improve the behavior of plastic components when exposed to fire, enabling compliance with the most stringent international health and safety regulations. In addition, hectorite and bentonite improve polymer compatibility and promote the delamination of filler stacks to create intercalated polymer-layered silicate nanocomposites.

CHARGUARD™ 1000 is a premium, medium-polarity magnesium-lithium silicate-based organoclay designed to boost the performance of fire retardant plastics. The highly delaminated, fine particle size distribution of CHARGUARD™ 1000 provides excellent anti-drip performance, particularly under high ambient temperature conditions. This makes it an ideal synergist for non-halogenated fire retardant formulations that require both aesthetic appeal and enhanced fire safety.

Its natural white color and extremely fine particle size distribution makes CHARGUARD™ 1000 exceptionally well-suited for applications in consumer electronics and white ware plastics, where a bright, clean, white appearance is essential.

CHARGUARD™ 2000 is a low to medium polarity, bentonite-based organoclay specifically engineered to enhance the performance of fire retardant plastics. This highly exfoliated organoclay delivers superior anti-drip and char formation properties, making it an excellent choice for a wide range of fire-retardant plastic compounding and masterbatch applications.

Made from highly exfoliated magnesium aluminum silicate, CHARGUARD™ 2000 is ideal for color neutral, darker, or opaque colored plastic compounding applications where color is less critical but fire safety is paramount.

CHARGUARD™ 2000 is particularly useful in industries such as wire and cable, construction materials, automotive, and industrial equipment.

CHARGUARD™ offers several performance benefits in thermoplastic compounding applications when compared with PTFE:

- **Non-toxicity and safety:** Organoclays are considered more environmentally friendly and non-toxic compared to PTFE, which can decompose at high temperatures to release potentially harmful gases (such as perfluorooctanoic acid, or PFOA). In applications where health and safety regulations are strict, especially in consumer appliance and building material applications, organoclay presents a safer alternative.

- **Reduced Environmental Impact:** Organoclays are naturally derived and can be considered more sustainable compared to PTFE, which is a synthetic fluoropolymer with potential environmental concerns related to its persistence and degradation byproducts.

- **No impact on processing temperatures:** PTFE has a very high melt viscosity and is difficult to process, often requiring specialized handling and processing conditions. It can also introduce challenges with flow and dispersion within the polymer matrix. Organoclays, on the other hand, are more easily incorporated into standard plastic processing techniques (e.g., extrusion, injection molding), leading to fewer complications in manufacturing.

- **Improved Char Layer:** Organoclays, when used as fire retardant synergists, promote the formation of a strong, cohesive char layer during combustion. This char layer acts as a barrier that protects the underlying polymer from heat and flame, enhancing fire resistance. PTFE does not provide the same char formation and is generally used for surface protection and lubricity rather than structural reinforcement during combustion.

- **Barrier to Heat and Gases:** The layered structure of exfoliated organoclays can act as a physical barrier to heat and combustible gases, further enhancing the flame-retardant properties of the polymer. PTFE lacks this layered structure and, while offering thermal stability, does not provide the same level of gas and heat shielding.

- **Mechanical Reinforcement:** Organoclays offer the added benefit of improving mechanical properties like tensile strength, flexural modulus, and stiffness, which PTFE does not typically provide. This is particularly useful in applications where both fire resistance and mechanical strength are needed, such as in automotive parts, construction materials, and electronic housings.

- **Synergistic with Non-Halogenated Flame Retardants:** Organoclays work well with non-halogenated flame retardant systems, such as aluminum hydroxide or magnesium hydroxide, by improving the char structure and reducing dripping during combustion. PTFE is typically used in formulations which may not align with the trend toward safer solutions for reducing toxicity and environmental impact.

Both products are available for sampling purpose only as a neat powder or pre-granulated as a 50/50 blend with polypropylene resin.

Note: The performance of CHARGUARD™ 1000 and CHARGUARD™ 2000 will vary depending on the type of thermoplastic resin being compounded and the specific physical performance requirements.

Improving sustainability and flame retardancy with synergism

The main benefits offered by synergistic combinations are:

- **Improved performance:** synergistic combinations can significantly improve the flame retardancy of materials. For example, antimony trioxide (ATO) as a synergist alone has no flame-retardant properties. However, when combined with brominated or chlorinated fire retardant compounds, the overall flame retardancy of the compound is much higher.

- **Cost-efficiency:** synergistic combinations can be more cost-effective because smaller amounts of each component are needed to achieve the desired level of flame retardancy.

- **Environmental benefits:** synergistic systems can reduce the need for halogenated flame retardants, which are often associated with environmental and health concerns. For example, combinations of phosphorus and nitrogen-based flame retardants, in combination with environmentally friendly performance-enhancing synergistic additives, can provide effective fire protection without the use of halogens.

- **Improved properties:** fire retardant synergists can also enhance other important properties such as mechanical strength, thermal stability and smoke suppression.

Fire-retardant synergists can be divided into viscosity modifiers (also called anti-drip agents) and char promoters. Certain types of synergists, such as organoclays, perform both functions.

Organoclays as flame-retardant synergists

Organoclays exhibit synergistic effects when combined with other flame retardants, enhancing overall fire retardancy. For instance, combining organoclays with phosphorus-based or nitrogen-based flame retardants improves flame retardancy and reduces smoke production more effectively than using flame retardants alone.

- **Enhanced char formation:** organoclays promote the formation of a stable ceramified char layer on the polymer surface during combustion. This char minimizes melt flow and acts as a barrier to heat and oxygen penetration, slowing thermal degradation and combustion and stopping the “refueling” of the fire.

- **Improved thermal stability:** incorporating organoclays into polymers (also referred to as intercalation) restricts polymer chain mobility and prevents volatile gas diffusion, thereby increasing the material’s thermal stability. This delay in decomposition onset reduces the heat release rate (HRR) during combustion.

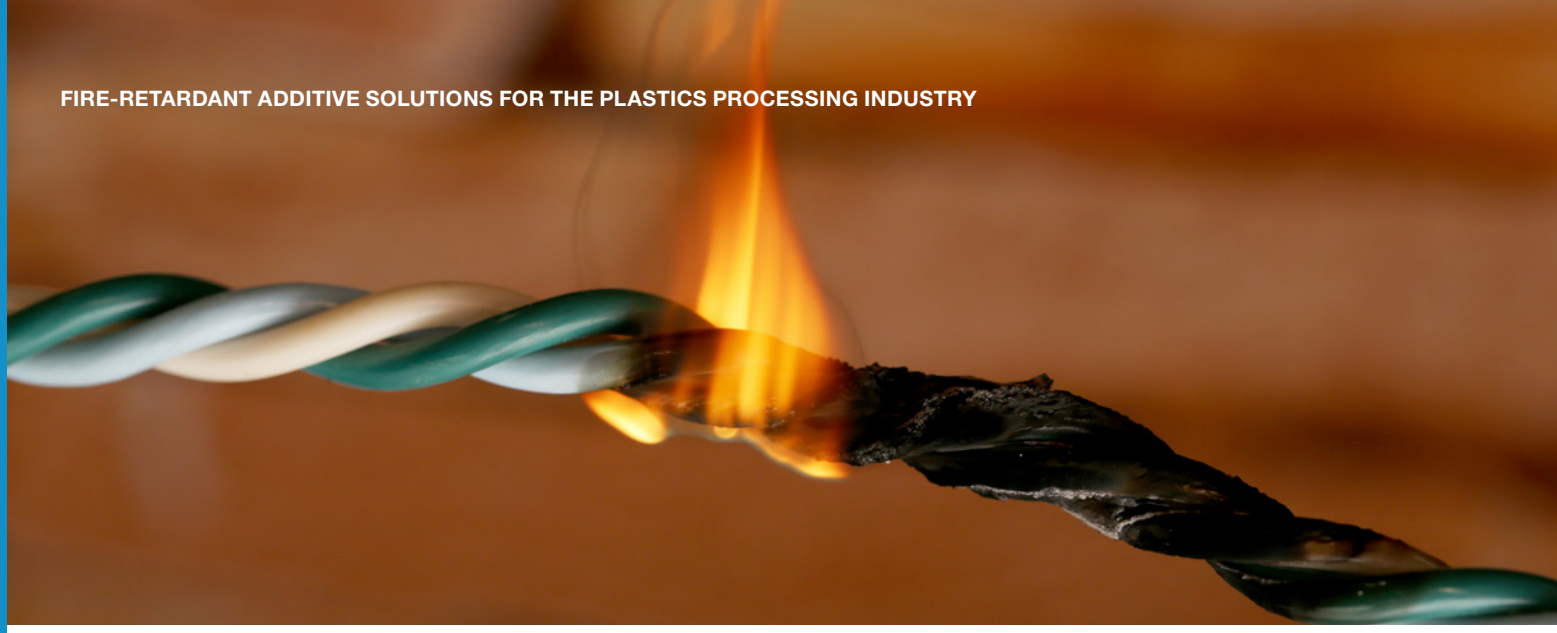
- **Reduced dripping:** organoclays reduce melt flow and dripping behavior during combustion. They do this thanks to their inherent shear-thinning, or thixotropic, properties. By increasing viscosity and promoting solid residue formation, they stop flame drip and spread of molten thermoplastics, which is critical to prevent the spread of fire.

- **Thermal insulation:** organoclays help prevent polymer degradation (heat aging) during voltage cycling.

The advantages of organoclays versus PTFE

One of the traditional compounds used for fire-retardant synergist applications is polytetrafluoroethylene, or PTFE. PTFE is associated with per- and polyfluoroalkyl substances (PFAS) which are toxic byproducts and environmentally persistent, making them overdue for replacement. What makes organoclays a good alternative?

- **Lower environmental impact:** organoclays provide a safer, halogen-free alternative to PTFE.
- **Regulatory compliance:** organoclays are more likely to comply with stricter environmental regulations, especially as many regions move to ban or limit the use of fluorinated substances (such as PFAs) due to their persistence and potential health risks.
- **Synergy with other additives:** organoclays can enhance the dispersion and stability of other additives in polymer matrices, improving the overall fire retardancy of the material. They can work synergistically with many halogenated fire retardants to provide more effective and consistent performance. PTFE is less compatible with other additives leading to potential challenges in achieving uniform dispersion.
- **Cost-effectiveness:** organoclays are typically more cost-effective than PTFE, both in terms of raw material costs and processing. Although used at lower rates of addition, PTFE is generally more expensive and can be more complex to process due to its high melting point and the need for specific processing conditions and specialized equipment.
- **Improved material properties:** unlike PTFE which primarily alters surface characteristics, not structural properties, organoclay significantly improves the structural integrity of the polymer by acting as a reinforcing agent, especially in applications needing high strength-to-weight ratios.
- **Smoke suppression:** organoclays form a vapor barrier during combustion. This reduces the amount of smoke emitted, improving visibility and reducing inhalation hazards during a fire, unlike PTFE.



The future of organoclay-based fire-retardant synergists

The use of organoclay-based synergists in the production of fire-retardant technologies brings numerous benefits, enhancing fire resistance and improving the mechanical properties of thermoplastics. They can also improve the cost-effectiveness of production and facilitate compliance with environmental regulations. And with Elementis organoclays, you can benefit from all these advantages and more.

Clays and organoclays are essential for many industries, including personal care, coatings, construction additives, plastics, and water treatment. At Elementis, we are proud to supply organoclays that meet these industries' evolving demands – in particular, hectorite organoclays. Hectorite is a versatile material with diverse functionalities and valuable properties. It offers easy, even application, sensory benefits, and a non-greasy feel, along with a high naturality index.

In recent decades, we have established ourselves as a leader in clays and organoclays, drawing on our expertise in mining, processing, and modification. Our hectorite mine, located in the heart of the Mojave Desert, is the largest and highest-quality hectorite source in the world. Clays from this mine are known for their superior purity and color.

Not only does this strategic asset ensure a consistent, reliable supply of hectorite clays, it also reflects our commitment to sustainability. Mining emissions for our hectorite clays are over 21% lower than those for similar clays. By minimizing their organic modification and purification processes, we further reduce our energy consumption. And we ensure the highest standard for human rights and biodiversity throughout our hectorite clays' lifecycle. This dedication to quality and sustainability underscores our leadership in providing superior organoclays.

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