# The Key to Achieving Fire-Resistant Material for the Transportation Sector

These days there are numerous promising materials technologies available that aim to fulfill both design and performance standards. Sectors within the transportation industry however face very specific challenges which still need to find smart solutions. One of the most important ones can be found in trains and aircrafts. In both cases interior is usually designed in ways that vertical and ceiling surfaces are comprised of materials which provide fire and smoke resistance and at the same time keep weight at a minimum.

Instead of spending time and money on the development of new materials, it is desirable to upgrade existing solutions. To remain with the example of train and aircraft interior: Often these structures consist of sandwich panels fabricated from face sheets of resins and fiberglass or carbon fiber reinforcement, and a strong core. Without proper measures, these unmodified polyesters and vinyl ester resins, unlike metals, can easily burn and release toxic smoke. The problem lies in their chemistry, as they are organic polymers which consist of at least one carbon compound. Hence making these structures fire and smoke resistant is a highly relevant topic.

## Meeting Safety Standards for Fire, Smoke, and Toxicity (FST)

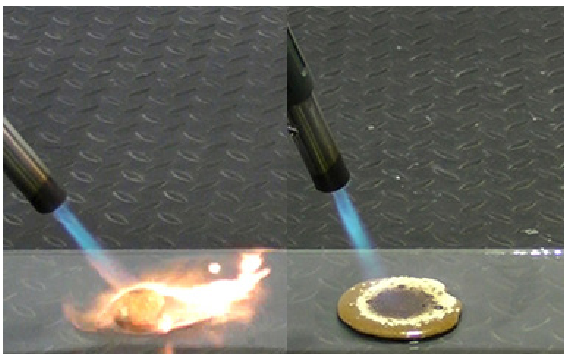
As described, composites are an excellent technology for weight reduction, however most thermoset resins still carry safety risk in mass transit applications. The combustion reaction, especially in the presence of other resin components, can produce toxic byproducts (e.g., carbon monoxide, nitrogen oxide), which contribute to failure when these resins are tested against federal standards.

For instance the Technical Center of the Federal Aviation Administration (FAA) has developed criteria for the current generation of improved fire-resistant interiors based on the description of the fire environment through a series of full-scale tests. Pre- and post-crash tests for instance regularly assess general flammability of materials and the toxicity of released gases and irritants. Hazard variables such as temperature, visibility, toxicity, and corrosiveness of smoke can be related to material properties, such as heat of combustion, heat release rate, smoke particulate yield, smoke extinction coefficient, and yields of combustion gases (e.g., $CO_2$, $CO$, low $O_2$, $HBr$, $NO_2$, $HCN$, and $HCl$).

Based on these evaluations, resin additives and fire-resistant thermoset resin formulations have been developed to meet federal and local safety requirements for control of fire, smoke and toxicity (FST). Today these well-established solutions are being joined by emerging alternatives, such as inorganic resins and specially developed fiber forms.

## Halogenated Organic Resins on the Decline

As a result of halogens contained in the fire-retardant additives in organic resins, a considerable amount of toxic smoke is still released if the material catches fire. In mass transit applications where smoke toxicity is of paramount concern, halogen use for this reason is declining as the resulting smoke is considerably more toxic than smoke from nonhalogenated resins.



The most widely used nonhalogenated replacement for flame retardant in the world due to its versatility and low cost is alumina trihydrate (ATH). ATH is non-toxic, halogen-free, chemically inert, and has low abrasiveness. Further, as it is available in different particle sizes, it can be used in a wide range of polymers at processing temperatures below 220°C. When an ATH-filled composite is subjected to temperatures above 230C/446F, the ATH exfoliates 35 percent of its weight as water while the remainder becomes noncombustible aluminum oxide. Besides acting as a heat reducing agent, the water vapor released during this endothermic reaction has an added effect of diluting combustion gases and toxic fumes. Additional benefits of ATH are arc and track resistance in plastics exposed to electrical arcing and acid resistance.

Even though ATH is very effective when it comes to meeting FST safety standards, when used as filler, it can have an undesirable impact on resin process ability.

## Overcoming Problems with Processability due to Alumina Trihydrate

To achieve fire retardancy in thermoplastics, the addition of large amounts of ATH is required. These additions however change the properties of the basic plastics material and lead to processing problems. Both processing temperature and embrittlement pose problems associated with funnel flow.

Recent R&D efforts have found ways to overcome these problems. For instance by **applying only small amounts of fire retardant filled resins to fiberglass sandwich structures, undesirable effects can be reduced significantly while still achieving FST** safe structures. Sandwich composite structures are well established in mass transport applications, but traditional core and sandwich materials have drawbacks that prevent the construction from achieving their full potential (weight, flammability, toxicity, etc.).

Studies conducted by the Parabeam Experience Lab evaluated how 3D glass fabrics (sandwich structures) in combination with the respective ATH filler resin perform in terms of handling (like mixing and impregnation), mechanical properties (like hardness) and laminate properties (color, smell and sound). Extensive tests and analysis revealed that particular adaptations still show the same properties as regular sandwich panels used in mass transportation, however were then also meeting FST requirements (as was seen in the Room Corner Test). This is due to the fact that specifically Parabeam 3D structures require less resins and therefor remain easy to process.

It is for this reason highly recommended to not completely switch to nonhalogenated nonorganic resins, but instead work out a balance between material and structure, such as resin-coated fiberglass sandwich panels.

PARABEAM

For a detailed report on the testing results conducted by the Parabeam Experience Lab, please contact sales@parabeam.com.