

# Safety Standard Increased

## Halogen-free, Flameproofed PC/ABS Alloys for Extrusion

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PVC has long been the material of choice for extruded plastic articles that must be flame resistant. But it suffers from the major disadvantage of releasing acidic and toxic gases in the event of a fire. This may not only present an acute security risk for

Halogen-free, flameproofed alloys of non-Newtonian polycarbonate and ABS are suitable for extruded profiles and thermoformable panels as well as for blow-moulded hollow articles. Products of such materials find application in electrical and telecommunications installations and in the construction and automotive sectors.

mankind and the environment. In even a minor building fire, it can also lead to considerable corrosive damage to electronic equipment and plant devices.

Halogen-free, flameproofed extrusion materials of the kind that have recently come onto the market offer specific advantages in this regard. Apart from halogen-free, flameproofed alloys of polyphenylene oxide and impact-modified polystyrene

(PPO/HiPS), developments in extrusion applications in recent years have mainly taken place in alloys of polycarbonate and acrylonitrile-butadiene-styrene copolymers (PC/ABS). Unlike many other polymers, PC/ABS alloys can be easily rendered flameproof by treatment with halogen-free, organophosphorus compounds. Driven by the generally increasing levels of environmental awareness,

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Company	Trade name	Injection moulding grades	Extrusion grades
Bayer	Bayblend	×	×
GEP	Cycology	×	×
Dow	Emerge/Celex	×	
Teijin	Multilon	×	
MEP	Iupilon	×	
Cheil	Staroy	×	
LG	Lupoy	×	

Table 1. Overview of the largest manufacturers of flame-resistant PC/ABS alloys

global acceptance of these products in many applications has increased over the last 15 years.

Traditionally, flameproofed PC/ABS alloys have mainly been used in information technology and the electrical engineering and electronics sectors. The chlorine-free and bromine-free grades used in these application segments are suitable to be awarded environmental recognition in the form of the Blauer Engel and TCO 99.

While the good flow properties of these polymers render them ideal for even demanding injection moulding applications, such as thin-wall articles, it was these very properties that until recently more or less precluded their use in extrusion, thermoforming and blow moulding. This was because the plasticising effect of the flame retardants prevented adequate melt stability from being achieved.

### Requirements of Fire Protection Fulfilled

While the global PC/ABS market is still dominated by injection moulding applications, various manufacturers have added flame-retardant PC/ABS extrusion materials to their lines (Table 1). Very recently, halogenated as well as chlorine- and bromine-free grades have been augmented by new products that comply with German cable standard DIN VDE 0472 Part 815 in respect of freedom from halogens and that contain no more than 0.2 wt.-% chlorine, bromine and iodine, and at most 0.1 wt.-% fluorine. Bayer AG offers such a product under the trade name Bayblend FR 3030. The required melt stability of these materials is created by a combination of non-Newtonian, high-molecular polycarbonates and specific, low-plasticising flame-retardant additives based on phosphorus. The new PC/ABS grades are especially notable for

- ▶ excellent flame retardance in a range of fire tests
- ▶ excellent light stability
- ▶ good stress-cracking and chemical resistance
- ▶ high heat resistance
- ▶ high rigidity and impact strength
- ▶ ease of extrusion, thermoforming and blow moulding, and
- ▶ yielding parts with excellent surface quality.

Combustion of halogen-free PC/ABS alloys naturally generates only extremely small quantities of hydrogen halides. The electrical conductivity of a solution of the fumes in water – a measure of fume corrosiveness – is well within the permissible threshold value specified in the above-mentioned standard (Table 2).

Cone-calorimeter tests show that PC/ABS extrusion grades produce roughly half as much smoke on burning as comparable halogen-free, flameproofed (PPO/HiPS) alloys. In terms of smoke formation, this puts them on a par with the rigid PVC normally employed in electrical installations.

In both an open and a smouldering fire, PC/ABS releases just small quantities of toxic gases. In fact, Bayblend FR 3030 even meets the high demands imposed by Airbus Industries on the release of toxic fumes by polymers in aeroplane cabins. Their tests assess the concentrations of certain toxic gases that are formed during the pyrolysis of the material in the absence and presence of a naked flame (Fig. 1).

Moulded parts of halogen-free, flameproofed PC/ABS alloys show an exceptionally positive response in standardized fire tests directed specifically at electrical installations, the construction sector and the public transport sector. Bayblend FR 3030, for example, passes the UL94 V test

for 1.5 mm wall thickness and has been assigned the highest rating of V-0.

Parts with walls just 1 mm thick that are exposed to temperatures of 960 °C comfortably pass the glow wire test and the needle flame test of IEC 60695. Cable ducts extruded from these materials fulfil the fire requirements of EN 50085-1 concerning duct systems for electrical installations.

In the standardised test of materials and parts for railway vehicles in Germany, known there as the “Bundesbahn test”, panels 1.5 to 2.5 mm thick score top marks in the ratings for best-possible re-

Product	pH	$\chi$ [ $\mu$ S/mm]
Halogen-free PC+ABS-FR	4.5	0.8
Halogen-free PPO+HiPS-FR	4.1	2.2
PVC rigid	2.5	413
Permissible threshold	>4.3	<10

Table 2. Corrosivity of fumes from different extrusion materials as set out in DIN VDE 0472, Part 813

sistance to flammability, smoke evolution and dripping. And, in the epiradiateur test regulating the use of polymers for railways and buildings in France, Belgium, Portugal and Spain, the materials achieved the top rating for organic polymers.

### Balanced Property Profile Combined with Ease of Processing

PC/ABS extrusion materials are notable for a very well balanced profile of application properties (Table 3). Their heat resistance is very high, being of the same order of magnitude as halogen-free, flameproofed (PPO/HiPS) materials, and is therefore about 30 °C higher than that of the rigid PVC used in electrical installations. Consequently, this PC/ABS lends itself to the production of moulded parts and profiles for use at elevated service or operating temperatures. PC/ABS has better mechanical properties than either (PPO/HiPS) or PVC. This allows wall profiles to be designed even more thinly and opens up the path to weight and cost savings. The specific density of PC/ABS is roughly 20 % lower than that of rigid PVC formulations for electrical installations, this fact providing further potential for weight reductions.

Due to the electrical characteristics that are typical for this kind of material, PC/ABS alloys make ideal electrical insu-

Property		Value
Heat-deflection temperature		
HDT/A (1.80 MPa)	°C	96
HDT/B (0.45 MPa)	°C	112
Vicat B120	°C	115
Mechanical properties		
Tensile modulus	MPa	2750
Yield stress	MPa	69
Elongation	%	5
Tensile stress at break	MPa	53
Elongation at break	%	> 50
Izod impact strength	23 °C kJ/m <sup>2</sup>	No fracture
	-30 °C kJ/m <sup>2</sup>	No fracture
Izod notched impact strength	23 °C kJ/m <sup>2</sup>	40
	-30 °C kJ/m <sup>2</sup>	10
Rheology		
MVR (260 °C; 5 kg)	cm <sup>3</sup> /10 min	10
Melt viscosity (260 °C/100s <sup>-1</sup> )	Pa · s	1100
Electrical characteristics		
Dielectric constant	100 Hz	3.2
	1 MHz	3.1
Dissipation factor	100 Hz 10 <sup>-4</sup>	37
	1 MHz 10 <sup>-4</sup>	75
Volume resistivity	Ω · cm	10 <sup>17</sup>
Surface resistivity	Ω	10 <sup>16</sup>
Dielectric strength	kV/m m	32
Tracking (CTI)		350
Specific density	kg/m <sup>3</sup>	1180

Table 3. Application properties of Bayblend FR 3030, a halogen-free, flameproofed PC/ABS extrusion material

lating materials. They have comparatively good stress cracking resistance to many chemicals, industrial greases and oils as well as to household solvents and cleaning agents. A further major advantage of PC/ABS alloys is their excellent light stability, which reliably satisfies the requirements of IBM-UV exposure tests (Fig. 2).

PC/ABS extrusion grades are notable for high melt viscosities at low shear rates and a high melt stability. The materials are extremely easy to extrude, extrusion-blow mould and thermoform. They are best processed at melt temperatures of 230 to

270 °C. The incorporated flame-retardant additives show no tendency to bleed. Consequently, processing will not be affected by deposits.

### Electrical Installation and Automotive Engineering

On account of the properties described, halogen-free, flameproofed PC/ABS alloys are suitable for electrical installation profiles, such as cable and wiring ducts and also for more geometrically demanding conductor rail support profiles. Various

manufacturers offer such products because there is a demand for them from public property developers, especially. The products offer clear advantages over metal profiles because they are easier to install. On account of their fire-safety advantages, halogen-free products are especially recommended for electrical installation in “high risk” areas, such as schools, hospitals and senior citizens’ homes as well as in buildings open to the general public, such as skyscrapers, public offices and airports.

The flameproofed PC/ABS extrusion grades are eminently suitable for the production of decorative and other types of trim for railway carriages and motor vehicles. Although requirements on the flame resistance of materials in bus interiors are still comparatively lax, some bus manufacturers are already using such materials so as to be able to offer a safety standard higher than legally stipulated for their vehicles (Fig. 3).

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Fig. 1. Smoke toxicity of Bayblend FR 3030 according to Airbus Standard ABD 0031/AITM 2.007. Gehalt der erlaubten Konzentration = Content of permissible concentration; ohne/mit Zündquelle = With/without ignition source; erlaubte Grenzwerte = Permissible threshold limits

Fig. 2. Comparison of the colour stability of flame-retardant extrusion materials on exposure to UV light in accordance with ASTM D 4459. Farbort-Änderung = Change in colour space; Bestrahlungsenergie = Radiant energy

Fig. 3. Trim parts in the driver compartment of Scania buses that were made by thermoforming extruded panels from a PC/ABS alloy