



Science For A Better Life

Thermoplastic Solutions for Light Weight Rolling Stock

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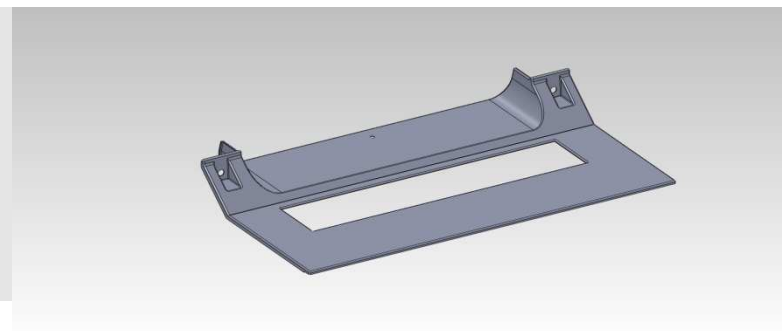
Bayer MaterialScience



Thermoplastic Solutions for Light Weight Rolling Stock

Synopsis: Thermoplastics have since long made their stand as a weight saving solution in automotive applications. They are widely used because of their ease of fabricating, high strength, light weight and recyclability. Except for rail: the new legislations related to fire protection are a real challenge to all materials used in the interior of rolling stock.

New developments have been going on in order to create thermoplastics which can comply with the new fire regulations. These novel products open up an array of possibilities for designers, fabricators and rolling stock manufacturers for light weight solutions for train interiors.





Agenda

- Industry Standards
- Specific Gravity Comparison
- Benefits of Thermoplastics
- Applications
- Case Studies



Regional Rail Standards Thermoplastic

- EN 45545
- DIN 5510-2
- NF P 92-501, -504, - 505
- NF F 16-101/102
- 49 CFR 223 Subpart B, Appendix: FRA Type I, FRA Type II
- 49 CFR 238, Appendix B: ASTM E162, ASTM E662
- Bombardier SMP-800C, Boeing BSS 7239

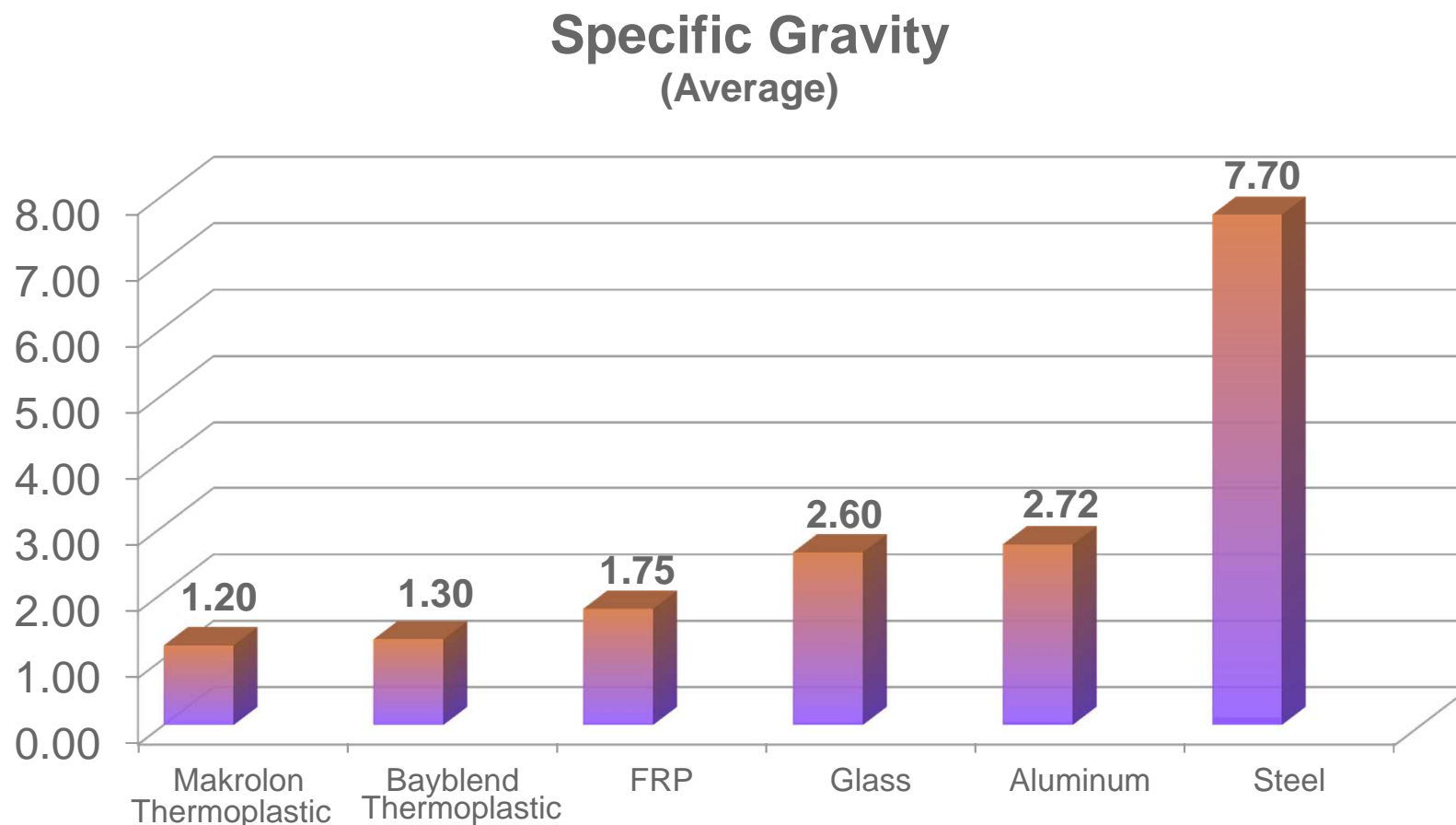
Regional Rail Standards Thermoplastic



Grade	EN 45545	DIN 5510-2	NF P 92-501, -504, -505	NF F 16-101/102	ASTM E 162	ASTM E 662
Bayblend MTX Sheet	HL2 at 2.5 mm (R1, R2, R3, R6, R7, R17)	Testing to be initiated	Testing to be initiated	Testing to be initiated	Testing to be initiated	Testing to be initiated
Bayblend FR 3030 Sheet & Resin	Does not meet	S-4/SR-2/ST-2	M1 at 2.0 to 3.0 mm	F2	Is<35 w/ flame drips	Ds (4min) <200
Bayblend MTR & MTR AG Sheet	Does not meet	S-4/SR-2/ST-2	M1	F2	Is<35	Ds(4min) <200
Bayblend FR 410 MT Resin	Does not meet	S-4/SR-2/ST-2	M1 at 1.5 to 4.0 mm	F2	Is < 35	Ds (1,5min) < 100 Ds (4min) < 200



Common Materials Passenger Rail Vehicles



* Relative density of a substance is the ratio of the substance to the density of water at 4°C



Polycarbonate Glazing Vs. Glass

Thickness	Makrolon Polycarbonate (kg/m ²)	Glass (kg/m ²)
2mm	2.45	4.99
3.2mm	3.81	7.83
4.75mm	5.72	11.74
6.35mm	7.63	15.65
9.5mm	11.44	23.48
12.7mm	15.26	31.30



Polycarbonate Glazing

Impact Resistant – approximately 200 times more impact resistant than float glass

Light Weight – approximately half the weight of glass at same thickness

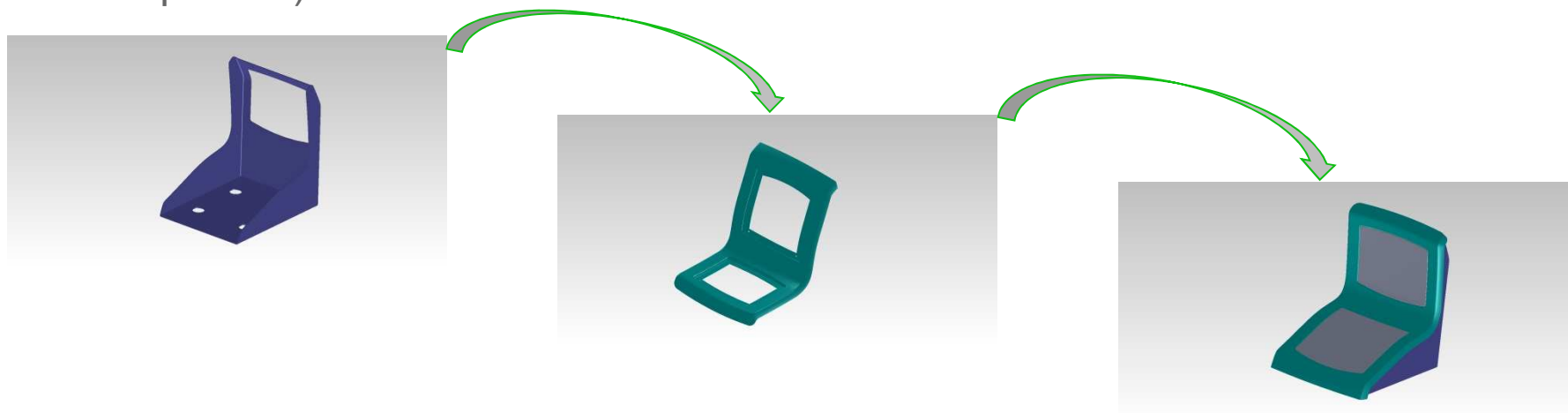
Abrasion Resistant – exclusive Bayer hard coating provides resistance from:

- Abrasion
- Chemical
- UV



Weight Reduction Benefits

- Less fuel/energy consumption
- Increased component life (brakes, propulsion system)
- Lower operating cost
- Reduction in CO₂ emissions
- Offsets weight increases created by additional components required to meet modern needs of rail operators (electronics/telecommunications, ADA compliance)





Weight Reduction Benefits

Application – Passenger Bus

(*) Studies (see annex) show that weight saving of 100 kg on a city bus can lead to 0.15 l/100 km fuel saving, on a long distance bus to 0.04 l/100 km. Over the whole life-cycle of a bus this accounts for 62,000 MJ primary energy savings = 4.5 ton CO₂ for a city bus, and 20,000 MJ primary energy savings = 1.4 ton CO₂ for a long distance bus

(*) ifeu – Institute für Energie – und Umweltforschung Heidelberg GmbH, January 2003



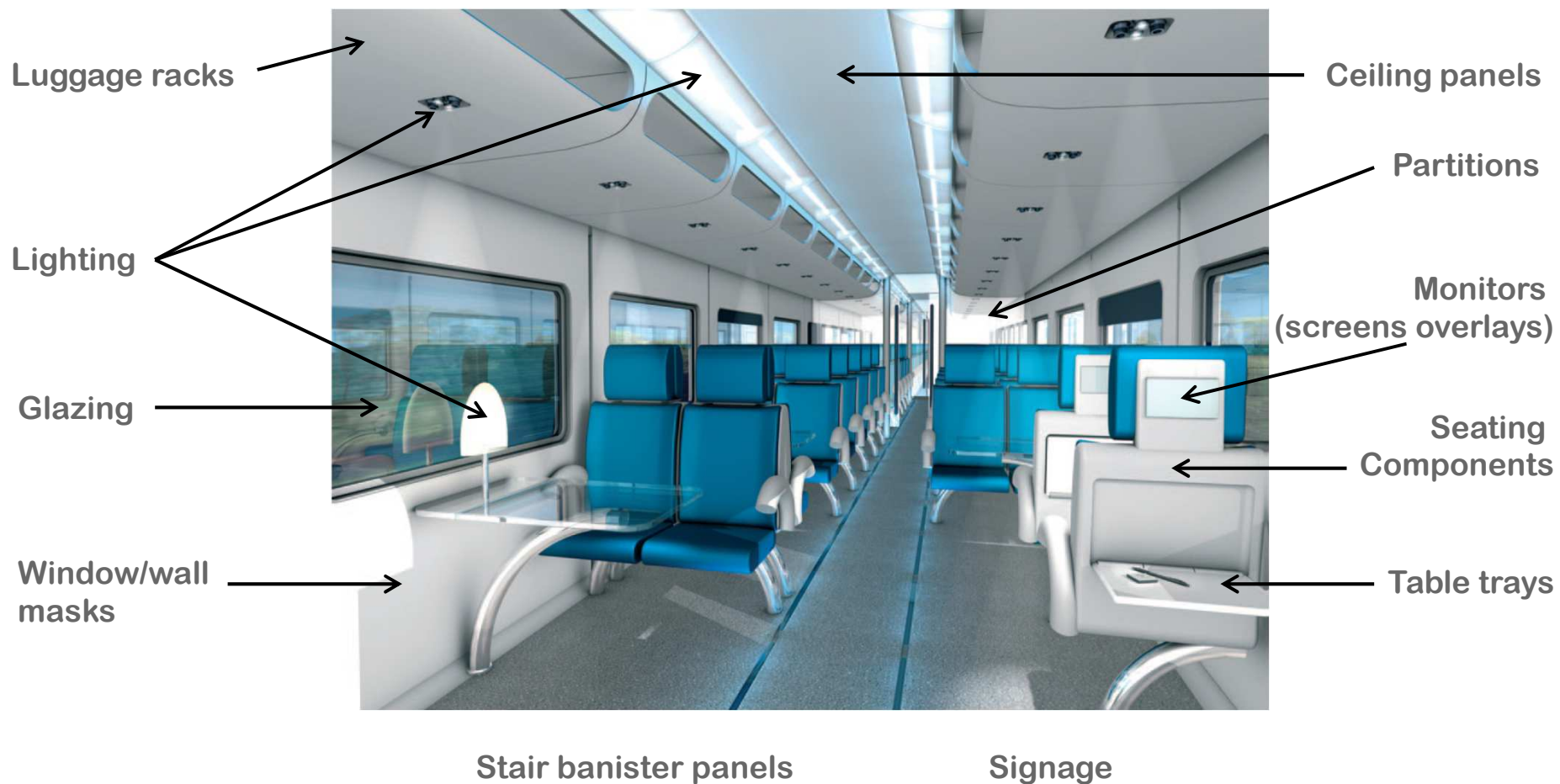
Advantages of Thermoplastic Sheet

Advantages of Makrolon and Bayblend Sheet Products

Exceptional design freedom	Light weight
High impact resistance	Fire resistant
Ability to be formed & bent into complex shapes	Environmentally friendly (recyclable, no VOCs)
Temperature resistant	Dimensional stability
Noise insulation	Anti-vandalism
Anti-graffiti	Wide range of colors and textures



Applications





Case Study

Seating, Bi-Level Commuter Car

Background: Bi-Level commuter rail car

Application: Thermoformed seat backs

Seat capacity per car: 179 passengers

Product: Bayblend MTR AG (3.2mm)

Total weight of thermoformed seat backs: 568kg/car (1,250#)

Total weight of FRP seat backs: 738kg/car (1,624#)

➤ **Weight savings per car:** 170kg/car (374#)





Case Study

Glazing, Bi-Level Commuter Car

Background: Bi-Level commuter rail car

Application: Glazing, passenger side window

Windows (side passenger) per car: 42

Product: Makrolon TG (polycarbonate) dual glazed with 6mm polycarbonate/6mm air gap/6mm polycarbonate

Total weight of polycarbonate windows: 569kg/car (1,252#)

Total weight of glass side passenger window: 1,166 kg/car (2,566#)

➤ **Weight savings per car:** 597kg/car (1,313#)



Questions?

A grayscale photograph of a high-speed train, likely a Shinkansen, traveling on tracks through a hilly, forested landscape. The train is white with dark accents and is moving towards the left of the frame.

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Thank you!