

CABIN INTERIOR PARTS INNOVATION: EPOXY PREPREGS

Von Roll introduce their cost-saving solution for parts manufacturing – the new Von Roll EP200 range of prepregs, developed with AI



The worldwide COVID-19 crisis has severely impacted the global aircraft industry. Production volumes will likely not return to pre-crisis levels before 2025. As a consequence, manufacturers are looking for opportunities to save costs. That means it's time to rethink the future of materials and processes.

Today, most of the prepreg chemistry used for interior cabin parts requires large amounts of solvents for transitioning from resin to prepreg. But because solvents produce a large amount of volatile emissions, they are often harmful to worker health, safety, and the environment. They also adversely affect the surface quality of the final composite part, which then requires additional processing before the final assembly. Furthermore, solvents have a negative impact on the glass transition temperature of the cured composite and its mechanical performance at high temperatures. Conventionally, phenolics are used in the prepreg for cabins due to their excellent FST properties. The problem: they

release phenol and formaldehyde when they cure, and without proper precautions, this also leads to health issues.

For next-generation cabin interior materials, the industry is looking for healthier, cost-efficient, eco-friendly, and more sustainable products all along the value chain. So that is where we started: we wanted to create a 100% solvent-, and phenol-free range of prepregs with a lower heat release rate and FST values, which would satisfy the stringent fire protection and retardancy requirements of the certification regulations, while delivering better mechanical performance than phenolic prepreg – also in terms of toughness and impact requirements for structural applications like floor panels.

The traditional path to developing new products relies heavily on the past experiences of scientists and their long-standing know-how, and employs several formulations, interactions, and experiments. This time, we introduced a new ingredient to the process. Our artificial

Properties	Test norm	Unit	Value	Standard industry requirement
Flammability, 12 s vertical – burn length	AITM 2.0002A	mm	50	< 200
Flammability, 12 s vertical – after flame time		s	2	< 15
Flammability, 12 s vertical – drip flame time		s	0	0
Smoke density – flaming mode 4 min	AITM 2.0007	Ds	60	< 200
Toxicity – HCN	AITM 3.0005	ppm	2	< 150
Toxicity – CO		ppm	120	< 1000
Toxicity – NOx		ppm	20	< 100
Toxicity – SO ₂ /H ₂ S		ppm	0	< 100
Toxicity – HF		ppm	0	< 100
Toxicity – HCl		ppm	0	< 150
Heat release rate: maximum in 5 minutes	AITM 2-0006	kW/m ²	45	< 65
Heat release – within 2 minutes		kW.min/m ²	45	< 65

Table 1: The standard FST and heat release values for sandwich construction with 2 plies per side EP220 reinforced with 7781 US style, core 3.2 – 48 kg/m³ 9.4 mm NOMEX honeycomb.

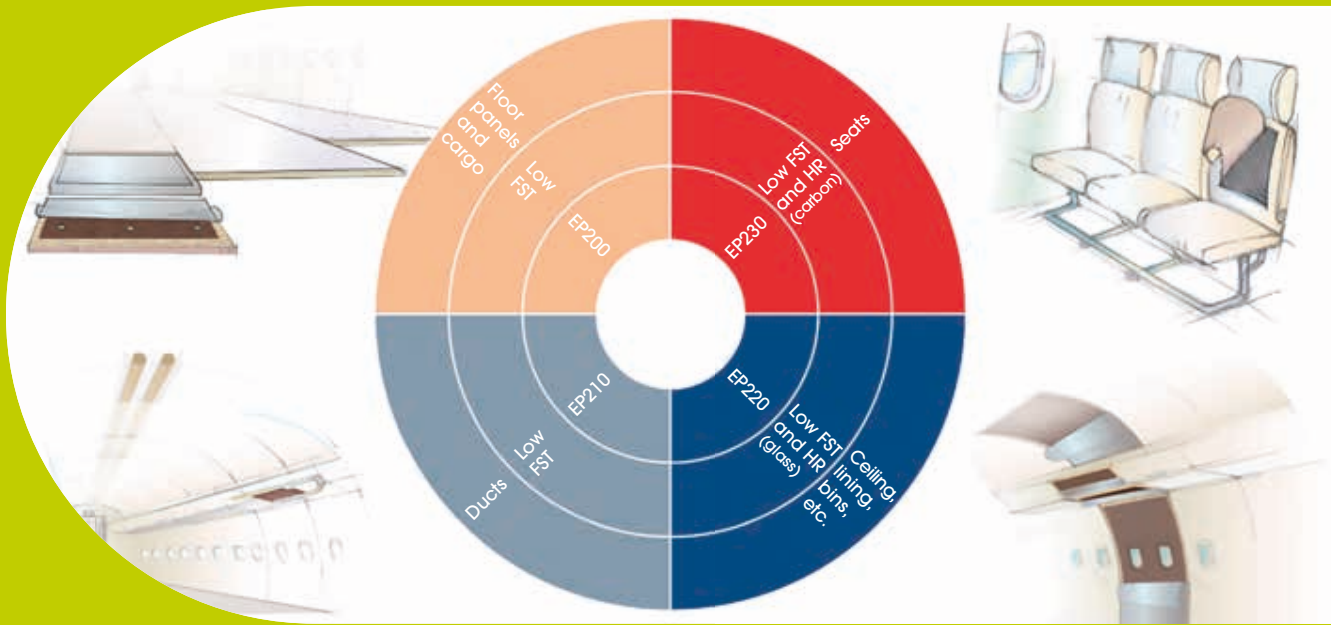


Figure 1: Applications of the EP200 prepreg series with fire-retardant epoxy-based systems.

intelligence (AI)-based approach uses all available technical requirements and the existing R&D data consisting of all relevant formulations, recipes and analyses generated in the past to develop ideal formulations. The AI was extremely thorough and efficient in identifying and analyzing all possible interactions, which allowed us to quickly develop a cost-efficient range of EP200 prepreg series with fire-retardant epoxy-based systems and to move from laboratory to industrial prepreg scale.

These resin systems effectively overcome the limitations of phenolic-based products and provide a very long shelf-life at ambient temperature conditions. They facilitate impregnation processes that are more than twice as fast as those based on vertical towers, which translates into 50% lower production costs and a 200% higher productivity on our new production line in Breitenbach, Switzerland.

Used in a wide range of aircraft cabin interior applications, our prepreg series currently includes the following variants: EP200 for cargo and cabin floor applications, EP210 for air ducting applications, EP220 and EP230 for cabin interior segments where low-heat release values are required such as ceiling panels, lavatories, walls, and seat components (see Fig. 1).

The EP200 prepreg suitable for sandwich construction shows flame time after vertical burning, smoke and toxicity values that are 70% below the maximum allowed. It exhibits excellent bonding to the honeycomb core with a measured climbing drum peel value of more than 250N/75mm when tested on a sandwich with two top and bottom composite skins, according to EN 2243-3 test standard.

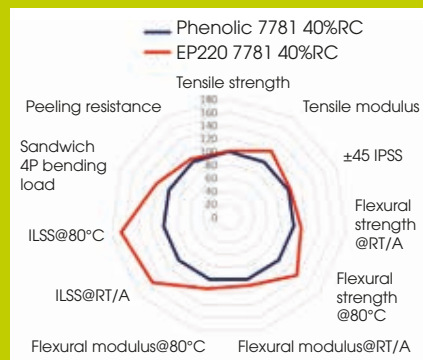


Figure 2: The chart compares the properties of EP220 reinforced with 7781 US style standard modulus glass fabric at 40% of resin content in weight and a similar product manufactured with standard phenolic resin.

Our EP210 prepreg is a system designed for manufacturing ducts with improved fire properties and low smoke values – it meets the regulations for parts with a thickness of up to 2mm. Smoke density emissions of about 80 Ds were registered when a 1.7mm part was measured in flaming mode according to 14 CFR 25, Appendix F, Part V. The combination of high tack and resin flow allows the product to be used effectively for air-conditioning ducting construction, without the use of autoclave or high pressure.

Used in various aircraft cabin interior applications, EP220 and EP230 prepreps can be processed to generate parts with 60% improvement in the interlaminar shear strength performance and 20% in the sandwich flexural strength compared to phenolics, which makes them ideal for designing interior

parts with lower weight (see Fig. 2). On selected critical lay-ups, they exhibited a peak heat release rate value lower than 45 KW/m² and a 2-minute heat release integral value lower than 45 KW min/m² when tested in accordance with the heat release rate (OSU) test for 14 CFR 25, Appendix F, Part IV. These values are almost an order of magnitude lower than standard epoxy resins and demonstrate a significant flammability performance benefit (see Table 1).

Using the new Von Roll prepreps can save up to 30% of total part manufacturing costs. That's because they can be stored longer at ambient conditions and because they eliminate pinhole defects on the surface, thus saving extensive labour costs associated with re-working those parts to achieve the high surface quality requirements for cabin interior parts. Finally, using these prepreps for seat applications will open the door for wider adoption of composites thanks to the achievable weight reduction of 30% for components traditionally manufactured from metals.

Summary and outlook

Using Artificial Intelligence for the first time to design a range of products with specific requirements proved a very inspiring and promising endeavour. The new Von Roll products provide significant benefits compared to state-of-the-art phenolics and improve sustainability. AI will remain part of our strategy in supporting the aerospace industry to achieve their CO₂ emissions reduction goals, for better compliance with environmental objectives and to satisfy market needs for durable long-term solutions for continuously improved passenger safety and comfort.