Case Study

Composite Bonding Enables Lightweight, Durable Body Structure for Polestar 1 Electric Performance Hybrid Vehicle

Project

Combining multiple substrates to create lightweight yet durable vehicle bodies packed with distinctive design features can be a challenge. This is exactly what Volvo's new electric performance brand, Polestar, aimed to do when announcing its first innovative model—the Polestar 1 electric performance hybrid.

The new vehicle features an upper body of carbon fiber reinforced plastic (CFRP) and steel composite—10 times stronger and five times lighter than steel—which enables the weight reduction that is critical to better fuel economy and battery performance. Carbon fiber also makes the vehicle body more rigid, creating more responsive handling—a must-have for Polestar's performance market segment.

However, composites can be difficult to bond. So, Polestar turned to DuPont.

DuPont put its expertise in 2K polyurethane composite bonding—earned on platforms including Volvo, BMW, Audi, and Aston Martin—to work on Polestar's revolutionary new vehicle.

Challenges

Performance

Polestar's engineers needed an adhesive that not only enabled a significant reduction in vehicle weight, but one that also reduced noise and protected against corrosion. Also important was the need to maintain design flexibility while achieving processing performance and sustainability goals.

Logistics

The Polestar vehicles were prototyped in Sweden and will be manufactured in China under a tight launch deadline. DuPont needed to not only come up with the right product, but also be agile and efficient in delivering it.

Assembly

Design features of the CFRP and steel composite components that comprised the SPA (scalable product architecture) body structure, resulted in bond gaps due to varying part tolerances. The bonding material effectively fills those gaps utilizing either hand held or robotic application equipment with cure and handling strength optimized to work in the Polestar assembly environment.

Solution

For Polestar, DuPont's BETAFORCE™ 9050L composite bonding adhesive was the material of choice to bond the vehicle body.

BETAFORCE™ is ideal for joining carbon fiber and glass fiber composites as well as other dissimilar materials in a variety of lightweight designs, including modular assemblies. For Polestar, it was an excellent choice for bonding CFRP panels to steel composites.

Support for the project during the first prototype builds in Sweden was critical to the success of the project. Similarly, development of a tailor-made heat-curing process at DuPont laboratories in Switzerland helped deliver a heat-accelerated formulation that was crucial to achieve the handling strength needed within a short process time. DuPont application development experts also helped establish the bond width parameters and then partnered with Atlas Copco to determine the ideal position for the adhesive bead on the car body. This ensured that everything would fit together properly during the curing, handling and assembly timeframe parameters.

Evaluation of the bond gap.

The influence of the bond gap onto the shear strength values was evaluated. Data was generated with 0.2 mm, 1 mm and 2mm bond gaps.

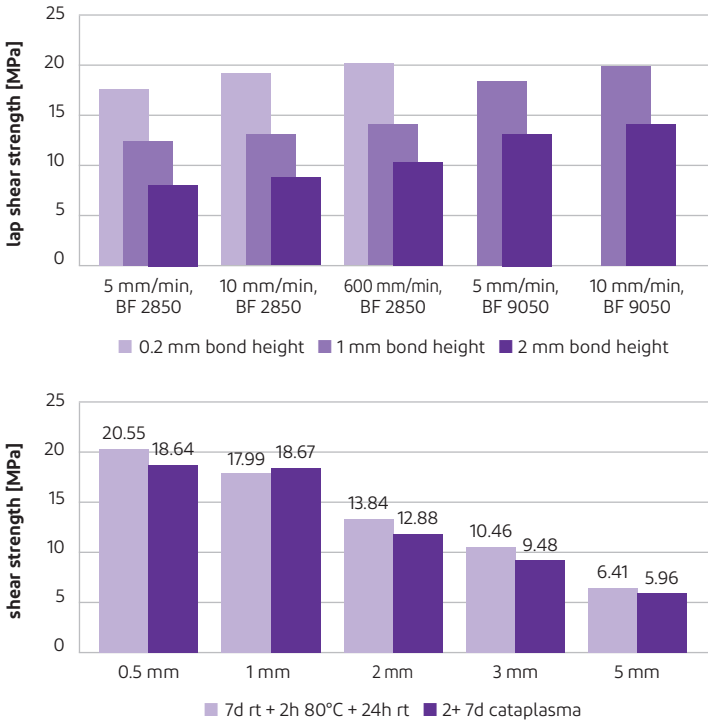

Figure 1.
Shear strength values in dependence of pull speed and bond height. Top: BETAFORCE™ 9050S. Bottom: BETAFORCE™ 9050L.

Results

To keep the project on track, and ensure maximum results, DuPont personnel were involved from the beginning. A DuPont team assisted on site with the commissioning of the material pump station. DuPont provided on-site training to operators and provided other process support, including correct pre-treatment of CFRP before the application of the adhesive.

"The ability to use CFRP–steel composite construction bonded by DuPont adhesives helped reduce vehicle weight by 300kg while also meeting the high standards for noise reduction and corrosion control," said Dr. Andreas Lutz, R&D Director, Adhesives for DuPont. "With 50 meters of adhesive used on each vehicle, we are proud of the strong role we've played in the rollout of this innovative and exciting electric performance vehicle platform."

DuPont™ BETAFORCE™ composite bonding adhesives

Developed for high-performance bonding in lightweight multi-material vehicles, BETAFORCE™ composite bonding adhesives from DuPont:

- Enable reduction in wall thicknesses
- Allow for optimization of substrates and adhesive joint structure
- Feature stable torsional stiffness over operational time windows that enable effective management of differential CLTE, even on long bond lines
- Enable process time reduction and significant investment savings due to very fast acceleration capabilities
- Reduce process complexity due to primerless performance
- Provide a corrosion barrier between dissimilar materials
- Reduce noise, vibration and harshness while improving crash performance
- Exhibit a broad range of mechanical and product properties
- Have very good bead stability during application

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