

Improved Strength and Cure Requirements Achieved with New Broad-bake Adhesive Technology



Battery weight in electric vehicles calls for more robust body structures including the sill, or rocker panel. On electric vehicles, the sill has a higher specific mass than internal combustion vehicles due to functional and design requirements, including supporting the weight of the battery pack. The sill is typically made with a multi-layer construction that is bonded with structural adhesives for added strength and durability. Structural adhesives require specific timeframes of heat – typically in the paint shop e-coat process, to acquire adhesion and mechanical strength.

Challenge

For its next-generation electric vehicle platform, Mercedes used an adhesively bonded steel and extruded aluminum multi-layer construction for its sill. This construction had an insulating effect that negatively impacted the adhesive strength and curing properties when applied in the body shop and subjected to standard e-coat baking processes. When faced with a choice of rebuilding the e-coat oven or coming to long-time adhesive supplier partner DuPont, the decision was easy – develop a new structural adhesive with a lower curing temperature window.

Solution

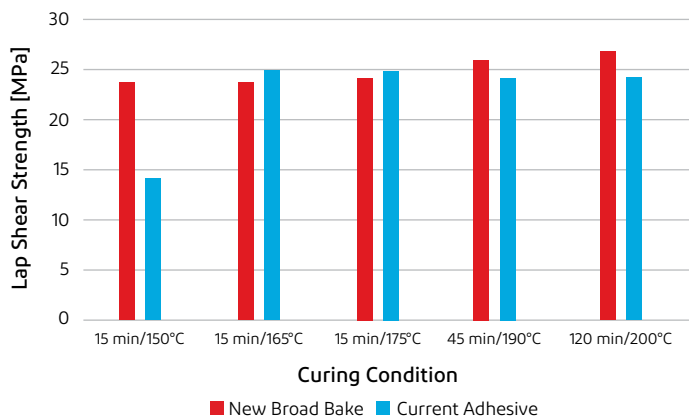
DuPont answered the challenge with its new development, BETAMATE™ 1650 broad-bake adhesive. More than sixty years of expertise in adhesives technology allowed DuPont to be first to market with the new solution within a short timeline.

Structural adhesives typically have a curing window of 165°C to 200°C. Mercedes required a wider window with a specification of 150°C for 15 minutes. BETAMATE™ 1650 has been tested and validated to perform between 150°C and 200°C – easily meeting Mercedes' requirement.

DuPont responded to a development order for a structural adhesive with a curing window of 15 minutes at 150°C up to 45 minutes at 190°C that also had to deliver on the following:

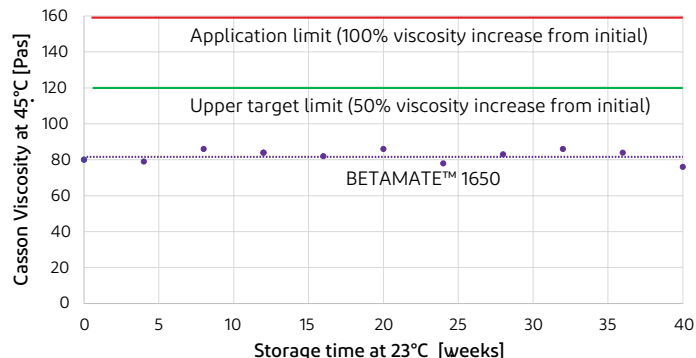
- Adhesion
- Mechanical strength (lap shear, T-Peel, and dynamic impact peel)
- Corrosion protection (loss of strength \leq 30% after aging)
- Wash-off resistance
- Open time/humidity resistance
- Application with existing technology/equipment
- Shelf life of 6 months

BETAMATE™ 1650 broad-bake adhesive exhibits lap shear strength within the 150°C at 15-minute requirement.



Source: DuPont

The newly developed BETAMATE™ 1650 broad-bake adhesive offers a shelf stability of significantly above six months at 30°C. The slow viscosity increase at nozzle temperatures enables a robust application process.



Source: DuPont

Result

The new adhesive achieved the desired curing condition that enabled mechanical performance for lap shear, impact peel and T-peel resistance, and demonstrated a 20 percent longer fatigue durability versus other structural adhesives. BETAMATE™ 1650 also met humidity resistance requirements even after 10 weeks of VDA 621-415 corrosion testing. In addition, in response to a secondary requirement for long shelf life, DuPont also delivered on a six-month shelf life from the time the product leaves the warehouse.

Realization of Development Targets

1. Full cure at 15 minutes / 150°C and shelf-life stability ✓
2. Mechanical performance and durability after 150°C cure ✓
3. Open time and wash-off resistance ✓

Sustainability advantages of BETAMATE™ 1650 broad-bake adhesive

New broad-bake adhesive technology allows automotive original equipment manufacturers (OEMs) to durably bond electric vehicle body structures utilizing a one-component body shop adhesive that stands up to an expanded curing window. This encompasses temperatures that can be reduced 20°C from current standards (160°C). The current minimum curing temperature is 12 minutes at 160°C (object temperature and holding time) and the released curing window is from 15 minutes at 150°C to 45 minutes at 190°C.

This technology reduces the need for sustained e-coat oven temperatures, thus providing energy savings. This adhesive technology – which has a shelf life of at least six months – also demonstrates excellent environmental exposure resistance and delivers high elastic modulus and tensile strength that helps enhance passenger safety by maintaining the quality and durability of the bond over the vehicle's lifetime.

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