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TegraCore™ PPSU Foam Sandwich Structures Deliver Superior Damage Resistance

TegraCore™ polyphenylsulfone (PPSU) foam is a structural foam core for lightweight sandwich structures targeted for use in insulative and structural components in aircraft interiors. This innovative material is based on Solvay's Radel® PPSU resin, a super-tough thermoplastic used for over 25 years in structural and decorative aircraft interior components.

Unlike other structural foams, TegraCore™ PPSU's closed cell foam exhibits exceptionally high damage tolerance thanks to the polymeric structure's proven ability to prevent uncontrolled crack propagation upon impact. The high-performance foam can withstand prolonged exposure to water, aggressive chemicals, and temperatures from -40 °C to 204 °C (-40 °F to 400 °F), and exhibits excellent thermal and acoustic insulative properties.

To assess the damage resistance of TegraCore™ PPSU foam, Solvay Specialty Polymers conducted testing that compared TegraCore™ R-1050 foam core sandwich structures to those made with an aerospace honeycomb (Hexcel's Nomex™ A1-64-3), which is a traditional core material.

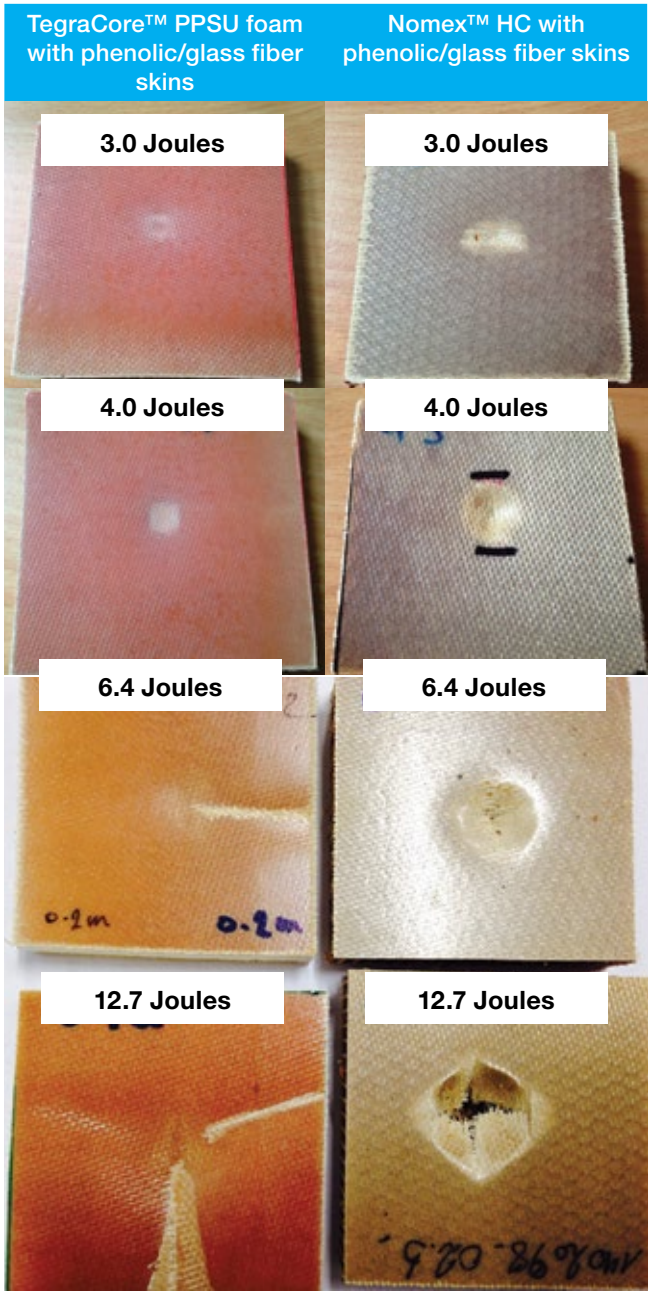
Test Procedure and Results

The drop-weight impact test as described in ASTM D7136 was used to measure the damage resistance of the sandwich structures, which were prepared using 15-mm-thick cores of PPSU foam or honeycomb sandwiched between two layers of 0.3-mm-thick skins on each side of the core that are made of a typical phenolic/glass prepreg (Cytec's MTM82S).

The drop-weight impact unit was operated with a 20-mm diameter hemispherical weighted to either 1 kg or 3.2 kg (2.2 lbs or 7.0 lbs). Drop heights ranged from 0.2 m to 1.0 m (7.9 in. to 39.4 in.) to produce impact energies up to 12.7 Joules (9.37 ft-lb).

A comparison of the surface damage observed at comparable impact energies presented in Figure 1 shows that the mechanical integrity of the TegraCore™ PPSU

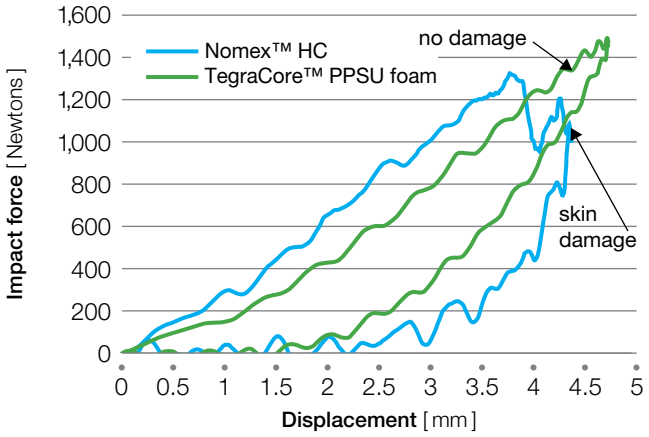
Figure 1: Comparison of impact damage to sandwich structures at increasing impact energies



foam sandwich is substantially better than that of the Nomex™ honeycomb (HC) sandwich. Pronounced indentation occurred in the honeycomb sandwich panel at the lowest impact energy tested, and then perforation was observed at the highest energy tested. In contrast, the TegraCore™ PPSU foam sandwich panel exhibited milder indentation at all energy levels and did not exhibit perforation.

Figure 2 shows the force-displacement curves for the Nomex™ HC and TegraCore™ PPSU foam sandwich constructions with phenolic/glass fiber skins. Despite the inherent greater stiffness of the Nomex™ HC sandwich construction, the overall force-displacement behavior or practical stiffness is similar to the TegraCore™ PPSU foam sandwich. The difference in the trajectory of the two curves also demonstrates the resistance of the TegraCore™ PPSU foam sandwich. This curve shows the impact and rebound curves measured on the TegraCore™ PPSU foam and honeycomb sandwich panels. The sharp drop in the curve, describing the impact on the honeycomb sandwich, indicates the damage that occurred to the skin.

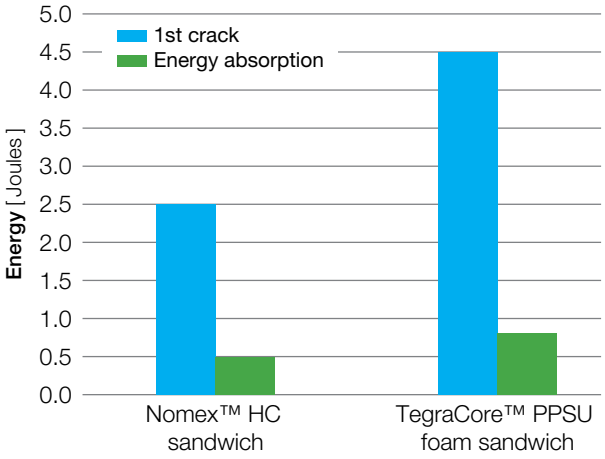
Figure 2: Impact test comparison of TegraCore™ PPSU foam vs. Nomex™ HC sandwich panel



An alternate way to describe this comparable behavior is to note that the TegraCore™ PPSU foam sandwich, built to similar dimensions as the Nomex™ HC sandwich, provides comparable in-service stiffness and superior resistance under impact versus the Nomex™ HC sandwich.

Figure 3 shows the overall impact energy required to create the first evidence of cracking and the amount of energy absorbed during the impact. Damage to the skin of the Nomex™ HC sandwich is observed at impact energy of about 2.5 Joules (1.8 ft-lb). This corresponds to an ability of the Nomex™ HC structure to absorb only 0.5 Joules (0.4 ft-lb) of energy before displaying visible damage. Damage to the skin of the TegraCore™ PPSU foam sandwich is observed at impact energy of 4.5 Joules (3.3 ft-lb). This corresponds to an ability of the TegraCore™ PPSU structure to absorb 0.8 Joules (0.6 ft-lb) of energy, thus providing approximately 60 % greater energy absorption than the comparable Nomex™ HC sandwich.

Figure 3: First crack and energy absorption comparison



Conclusion

TegraCore™ PPSU foam core sandwich structures provide significantly better damage resistance than comparable Nomex™ HC core structures. Perforation of the honeycomb core skin layer occurs at relatively low impact energy while the integrity of the PPSU foam core structure is maintained at more than twice the impact energy that penetrated the skin of the honeycomb structure.

Based on these test results, TegraCore™ PPSU foam is an excellent candidate for foam core sandwich structures used in sidewall, ceiling, and privacy panels as well as seat shells, luggage bins, and radomes.

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