



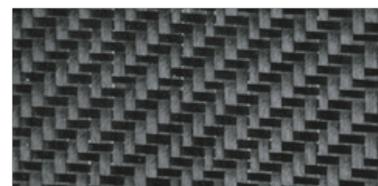
Advancing Organosheets via Material Card Development

The First LS-DYNA Material Card for a JM Neomera® Organosheets

Organosheets are **continuous fiber reinforced thermoplastic sheets** containing primarily glass or carbon fiber fabrics. Recently, organosheets have begun to encompass a broader range of semi-finished products that share key advantages deriving from thermoplastic matrices, from polypropylene and polyamide 6 to polyethylenimine, and the diverse architecture of the reinforcing fibers. Organosheets have a strong built-in advantage: they **contain fully polymerized thermoplastic polymers (organic materials)**. Unlike thermoset prepregs, which have limited shelf life and require refrigeration and specific inventory control, organosheets **can be stored for extended time** under typical temperature and relative humidity conditions determined by the thermoplastic polymer they contain.

The sheets can be **cut to shape, stacked, and integrated in automated manufacturing processes** that resemble the processing of metal sheets. This similarity to metal sheets – often referred to as blanks by metal component stampers – is particularly helpful when discussing applications with automotive industry stakeholders.

Johns Manville has developed an innovative process for producing polyamide-6 (PA-6) composite sheets. The new proprietary technology is based on anionically polymerized PA-6 (AP nylon) and fiber reinforcements (glass fiber, carbon fiber or hybrids).

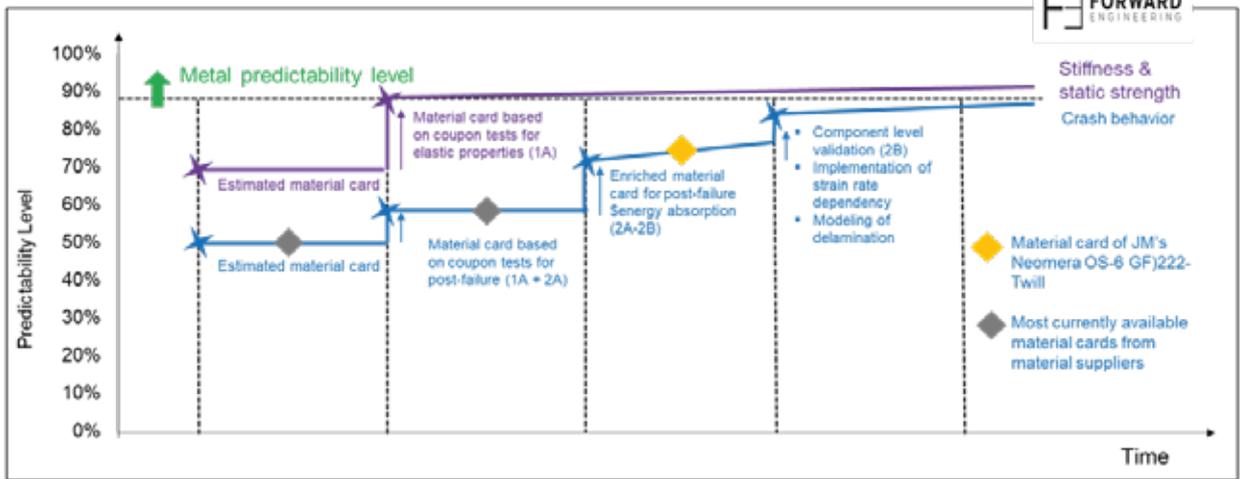


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One of the challenges of advancing organosheets in structural applications is the ability to predict the materials' performance. The Thermoplastic Composites team at Johns Manville is constantly engaging in conversations with potential users to address gaps in the characterization of the new organosheets to accelerate the materials' adoption in structural applications for which simulation-driven design is key for advancement.

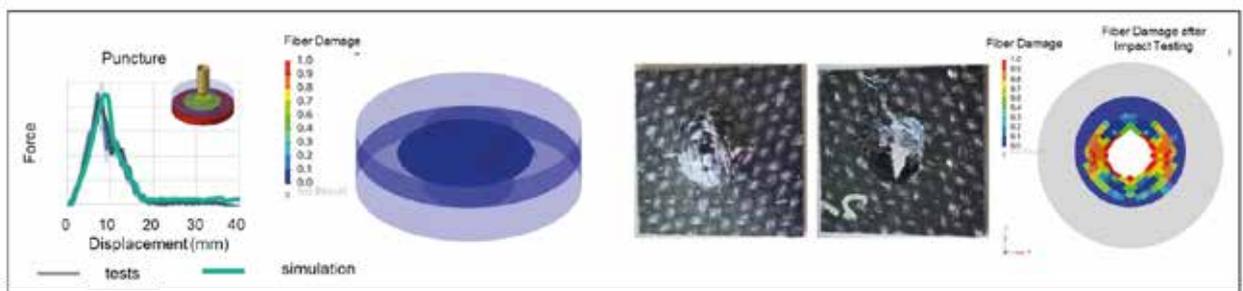
In 2022, JM partnered with Forward Engineering GmbH (FE) to develop crash material cards for the Neomera® organosheets, to accurately represent each combination of fiber, resin, and fiber architecture. FE's standardized, modular crash material card development program is delivering accurate, ready to use crash material cards for fiber reinforced plastics such as the organosheets. The first JM organosheet characterized using this model was a Neomera® OS-6 Series glass fiber organosheet based on 2/2 twill fabric.

| PRODUCT DESCRIPTION | VALUE & UNIT |
|---------------------|--------------------------|
| Fiber | E-glass, JM StarRov® 886 |
| Weaving style | 2/2 twill |
| Fabric area weight | 1200 g/m ² |
| Yarn/Yarn count | 2400 tex (g/1000m) |
| Fiber content | 46% (vol) |
| Thickness | 2.0 mm ± 0.2 mm |
| Sheet density | 1.75 g/cm ³ |



Predictability levels reached with the Forward Engineering modular crash material card development program

The initial estimated material card was refined based on coupon tests, and enriched to include post-failure energy absorption, which significantly increased the predictability level for the organosheet in crash simulation. The predictability can be further improved by working directly with the end-users, typically tier 1 suppliers or original equipment manufacturers, through application specific testing including component-level validation, and by implementing strain rate dependence.



The calibrated material card demonstrates the high energy absorption in simulations

Neomera®OS-6 material card is available on request.

Samples

Johns Manville's Composites in the OS-6 and NCF-6 Series are semi-finished sheets. Samples, including cut to-shape sheets, are available on request. Depending on fabric configuration, wider sheets (up to 1.6 meter) are available.

About Johns Manville

Johns Manville, a Berkshire Hathaway company (NYSE: BRK.A, BRK.B), is a leading manufacturer and marketer of premium-quality building and specialty products. In business since 1858, the Denver-based company has annual sales of \$4 billion and holds leadership positions in all the key markets that it serves. Johns Manville employs 8,000 people and operates 44 manufacturing facilities in North America and Europe.

CONTACT

Dany de Kock
Market Development Manager
Johns Manville
+32 473 75 44 96
dany.dekock@jm.com

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