ARNITEL® PM471

The Most Reliable Solution for Airbag Covers

Challenges faced in selecting materials for airbag covers:

- Excellent deployment behavior from -35°C up to + 85°C
- Perfect aesthetics
- Freedom of design

ARNITEL PM471 IN AIRBAG COVERS

Arnitel is the reliable solution for airbag covers

- Arnitel PM471 outperforms competitive materials in airbag cover cold deployment tests at -35°C (-30°F) ("in chamber") with no splintering / fragmentation or crack initiation having been observed even at this low temperature.
- Arnitel PM471 enables lower VOC emissions and a healthier working environment as it can be painted with water-borne paints even without a primer.
- Arnitel PM471 displays excellent adhesion to Polycarbonate/ABS blends. This allows the housings and covers to be molded in a single production step resulting in new design opportunities and lower overall system costs.
- Airbag covers made from Arnitel PM471 open more easily during deployment. This allows for designs with thicker tear seams, which facilitates tool filling and gives better aesthetics (less read-through).

DSM has years of experience delivering technical support for design, tooling, molding, and painting of airbag covers. In addition to Arnitel PM471, tailored for excellent deployment at -35°C in chamber and painted, DSM offers a wide range of other Arnitel grades.

Airbag cover function

The function of an airbag cover is to protect a folded airbag during the lifetime of a car and to ensure proper functioning in case of an accident. The cover material needs to have sufficient strength and stiffness to meet the structural integrity demands during daily use and still open along its tear seam very easily in the case of an accident.

The opening of an airbag cover takes place in less than one millisecond, resulting in tear seam propagation speeds of over several hundred meters per second. Under these extreme high-speed conditions the material has to maintain ductile behavior, even down to temperatures as low as -35°C (-30°F). Fragments or splinters may not be formed during cold deployment because they can be lethal at the high propagation speeds encountered.

The automotive trend to higher safety standards is resulting in higher demands from OEM's on the test procedures including:

- Temperatures as low as -40°C (-40°F)
- Move towards "in chamber" testing

Cold deployment testing inside a climate chamber is much more demanding than conducting the tests outside the conditioning chamber. Typical delay times are 3 minutes whereas after one and a half minutes a thin tear seam has already reached a temperature higher than zero °C (see Figure 1). In that case a lot of other materials may appear to meet the requirements but fail to perform correctly in actual low temperature conditions.

To facilitate deployment simulations during the design phase, DSM has generated input data for the numerical calculations based on high-speed tensile test conditions. This data shows that Arnitel PM471 is still very ductile under high speed conditions, with an elongation at break around 50% (see Figure 2) even at -35°C (-30°F). "Material Karten" for PAMCRASH software have been established at the Fraunhofer Institute at Freiburg and is available on request.

Figure 1 Temperature increase at the center of a tear seam (0.6mm) compared to a typical cover thickness of 2.5mm as a function of the time outside the cold climate chamber (-35°C).

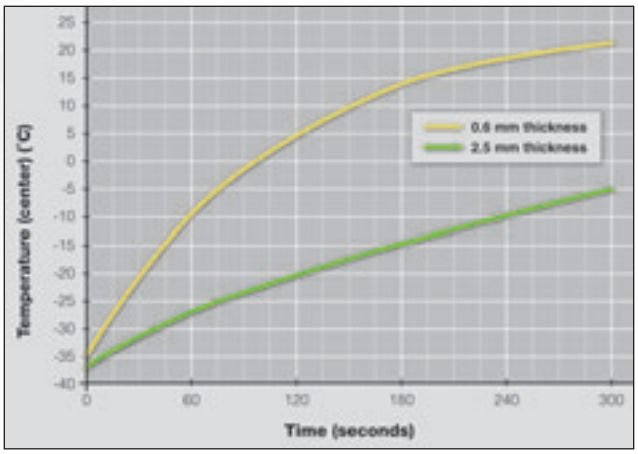
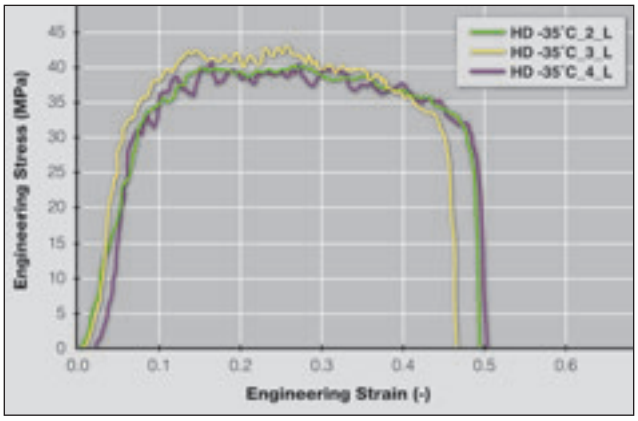


Figure 2 Arnitel PM471 still shows very ductile material behavior in a high speed tensile test at -35°C (strain rate 10^2 1/s). High speed tensile testing performed at EMI, Fraunhofer Institute Freiburg (report EMI I-45/03).



Molding and tool design

Injection molding airbag covers is far more critical than for many other injection molded parts. The combination of complex shaped thin tear seams (< 1mm) with relatively thick parts for construction purposes (3-4 mm) requires the highest level of injection molding expertise. DSM has an expertise center to service its customers (OEM's, system suppliers and molders). This center provides support during design (with CAD), when tooling (via Mold Flow simulations), and during molding (via direct technical service).

The following guidelines for molding and tool design will help achieve proper functioning of an airbag cover:

1. Because thermoplastic materials are viscous and tend to stop/freeze at very thin tear seams, it is recommended to use a tear seam thickness > 0.5 mm. The figures below illustrate that a 0.8 mm tear seam in Arnitel PM471 opens as easily as a 0.5mm seam made from a competitive TPE-E material. The excellent opening characteristics of Arnitel PM471 help ensure the safe deployment of the airbag cover.

2. To prevent discontinuous filling over the tear seam it is recommended to make use of multiple gating. This can be done by positioning the sprue gates at 6 and 12 o'clock. The goal is to fill the biggest part of the cover before the melt front reaches the thinnest region of the tear seam (initiation zone). At that point the melt front has few possibilities other than to flow across the thin tear seam without stopping.

3. To prevent uncontrolled tear propagation and brittle cold deployment, ensure that weld lines (due to multiple gating) are positioned 10-15 mm (0.40-0.60 in) from the tear seam (Figure 4). Never position a weld line at the tear seam.

4. Complex tear seam patterns can result in air entrapment during molding causing bad aesthetics and affecting paint adhesion (via dieseling). By performing mold flow simulations, DSM can advise on how to avoid this.

5. To avoid bad aesthetics and paint adhesion problems at the edges of the cover, care should be taken to properly vent the tool (avoid dieseling). Vent channels should preferably be provided all around the cover, and specifically at those regions of the tool that are filled last.

6. Arnitel PM471 exhibits good mold release under normal circumstances. Care should be taken during tool design to ensure proper release of the airbag cover. It is not recommended to solve release issues that arise from poor tool design by adding release agents or applying PTFE or silicone coatings to the tool as this will negatively affect paint adhesion.

Figure 3 Amount of energy required to open a tear seam of 0.5 and 0.8 mm thickness for both Arnitel PM471 and a competitive co-polyether-ester elastomer.

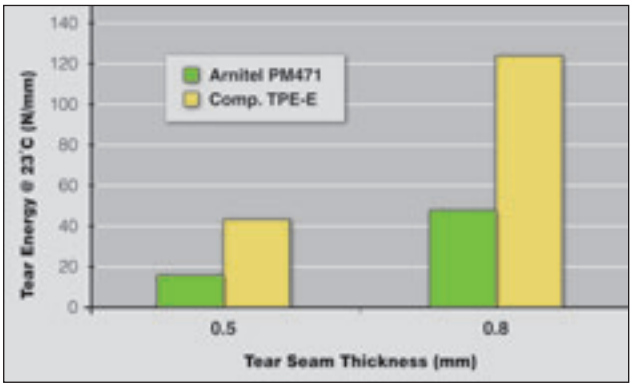
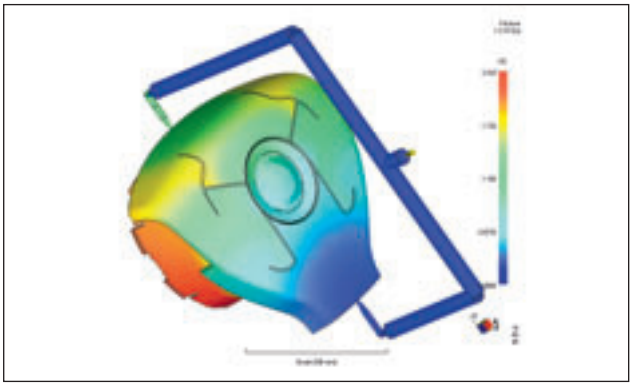


Figure 4 Example of filling pattern using double (cascade) gating at 6 and 12 o'clock. Weld line is positioned some 10 mm above the tear seam.

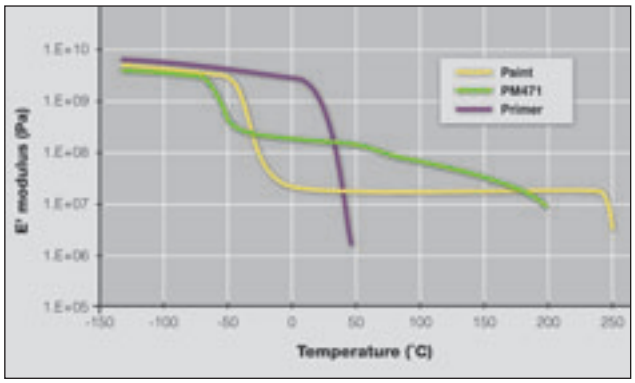


ARNITEL PM471 IN AIRBAG COVERS

Painting

To meet the higher aesthetic requirements demanded these days by OEM's, the majority of airbag covers are painted with "soft paints" which provide a perfect color match with the surrounding parts and enhances the soft touch. In addition to properties like UV-resistance, scratch & mar resistance, and adhesion, the mechanical behavior of the paint is extremely important. The paint layer should have ductile behavior at -35°C (-30°F) to ensure proper cold deployment behavior of the painted airbag cover. Using a brittle paint (or even a primer as with most of the TPO systems) can cause crack initiation at the paint surface with fragmentation as a result. DSM has extensive information on suitable Soft Paint systems for airbag covers. An example of a brittle primer is illustrated in Figure 5.

Figure 5 Dynamic Mechanical Analysis shows the E-modulus as a function of temperature for the Arnitel PM471, a paint layer and a primer. The primer is very brittle at -35°C.



KEY PROPERTIES

Key properties of Arnitel PM471 at a glance

- Consistent mechanical behavior over a wide temperature range [-35°C (-30°F) up to + 85°C (185°F)]
- No brittle behavior at low temperatures
- Outstanding dimensional stability
- Overmolding with i.e PBT, PC/ABS (compatibility)
- Easy processing (thermoplastic)
- Easy design properties

Europe
The Netherlands

DSM Engineering Plastics
Poststraat 1
P.O. Box 43
6130 AA Sittard
Tel. +31 46 47 70075
Fax +31 46 47 70101

USA
North America

DSM Engineering Plastics
P.O. Box 3333
2267 West Mill Road
Evansville, IN 47732-3333
Tel. +1 812 435 7500
Fax +1 812 435 7702

Asia Pacific

DSM Engineering Plastics Asia Pacific
11F, The Headquarters Building
No. 168 Middle Xi Zang Road
Shanghai 200001
China
Tel. +86 21 6141 8188
Fax +86 21 6141 7010

DSM Engineering Plastics

www.dsmep.com - www.arnitel.com