Thin-wall Foaming for Vehicle Interiors

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Exceptional interior space materials, which create unique accents and are both optically and haptically impressive, contribute to the comfort of high-grade vehicles. For component production, however, the diverse choice and combination possibilities of the end customer represent a challenge. This is where the thin-wall foaming process developed by Dräxlmaier makes it possible to apply all of the available surface materials to a single carrier.

THE IMPORTANCE OF THE VEHICLE INTERIOR

In the premium segment of the automobile industry especially, interior design is a major priority. With this in mind, instrument panels are offered which are covered with exceptional sewn surface decors made of artificial or genuine leather. This reflects the ever stronger desire for personalization and at the same time conveys the premium feeling promised by the OEM. By combining shapes, surfaces and colors, it is also possible to create a unique design that supports the brand identity of the OEM. Interior surfaces are no longer mere decoration, but an essential part of the overall premium concept.

DIFFERENT SURFACE STRUCTURE

Since Dräxlmaier first produced an instrument panel with flexible leather for the first time in the 1990s, this tactilely appealing type of covering has established itself in automotive interior design with a sewn trim. In addition to hand-machined seams, leather or synthetic leather surfaces of this type are distinguished by the knitted padding fabric which is responsible for the pleasantly soft feel. The total thickness of this top variant composite of surface material and knitted padding fabric is between 2.9 and 4.4 mm, depending on the vehicle model, **FIGURE 1**.

In order to meet the requirements of as many automobile buyers as possible, a so-called basic variant is always offered in the premium segment. Here, suitable surface materials include high-grade special plastics made from Polyurethane (PU), Polyvinyl Chloride (PVC) or Thermoplastic Polyolefins (TPO). These are produced using various methods, including the slush skin method, the spray skin method or the deep drawing of grained or in-mold

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grained TPO films. As in the case of the leather variants, great value is placed on a pleasantly soft feel, which is usually achieved by adding a layer of PU foam between the carrier and the surface material. In terms of the safety aspects, too, this production step has a positive effect since this cushion acts in a shock-reducing manner upon contact.

In order to achieve process-oriented flow paths, especially in large-area components such as instrument panels, high foam thicknesses are almost always required. As a result, a relatively large amount of material is required for the flexible backing of the surface. Thus, on the one hand, the weight of the component increases. On the other hand, the required foam layer thicknesses of 6 to 12 mm lead to a significantly higher overall thickness of the trim compared to sewn surface variants, **FIGURE 1**. If different materials or manufacturing methods are to be used for the component surfaces, then several different carrier variants within the same vehicle series must be developed, produced and maintained when classic production methods are used.

COMMON SOLUTIONS

While the choice between different types of trim for the end customer represents a welcome personalization option, this results in increased expenses for the vehicle manufacturers and their suppliers in terms of the provision of facilities and tools as well as for additional coordination processes. To reduce these effects, there are already various methods available on the market, with which a more efficient production of the different component variants can be achieved.

One of these methods involves using a so-called reduced dimension of the carrier onto which the sewn decoration is mounted. However, this production method has significant disadvantages: It requires separate smaller tools as well as an additional smaller sized skin. This changes the haptic properties of the final component surface and leads to an increase in weight.

In the case of the so-called dummy skin process, a skin of silicone is back-foamed and then removed again. This skin serves as a placeholder and has the same dimensions as the subsequent sewn layer. The dummy skin is replaced by the trim, which is the actual visible surface of the instrument panel made of artificial leather or genuine leather. For this purpose, no second carrier tool and also no smaller sized skin or film are required. A disadvantage of this process is that the silicone skin used must first be produced in a separate tool and at the same time can be reused only for a certain number of cycles.

BENEFITS OF THE NEW METHOD

With thin-wall foaming, Dräxlmaier has developed a new method which, even in the case of large-area components, makes extremely thin foam fillings possible, since, unlike in the case of conventional back-foaming, no minimum foam thicknesses are required. Thus, a thin-wall foamed base variant can be applied to the same injection molding carrier as surfaces made of artificial leather or leather variants with decorative seams – without smaller sizes, silicone skin or a separate tool rail. Compared to conventional production methods, the use of thin-wall foaming makes it possible, independently of the surface design, to use the same space-optimized carrier, as all trims have a similarly low overall thickness, **FIGURE 2**. Due to the practically identical dimensions of all components, the same add-on parts can also be used.

PRODUCTION PROCESS

In thin-wall foaming, a thin foam film is applied to a decorative skin by means of robot-assisted spray injection and then

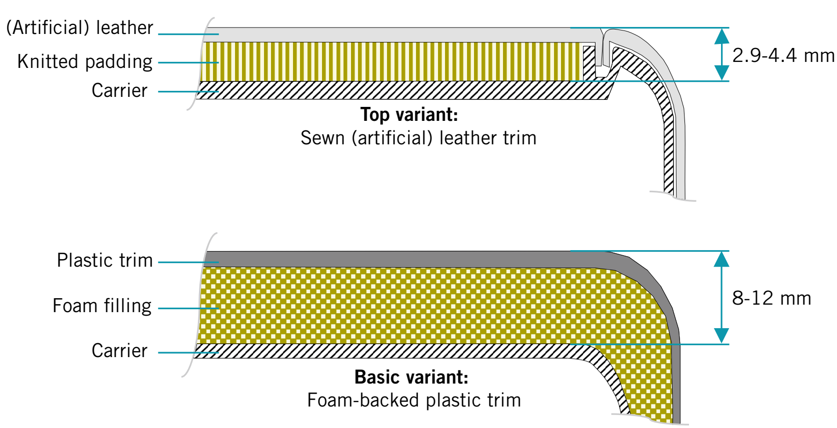

FIGURE 1 Top and basic variant in the premium segment: sewn leather and artificial leather variants have a significantly flatter structure compared with conventional foam-backed plastic trims, which is why different carriers are traditionally used (© Dräxlmaier)

connected to a carrier. In this case, the open design of the tool is an essential distinguishing feature for classic back-foaming: Standard foams require a closed form due to the large volume increase and the high forces within the tool in order to achieve a stable foaming result. In comparison, the thin-wall foaming process manages this without any seal in the edge region while providing full-surface support for the carrier, **FIGURE 3**. This is made possible by the short flow paths of the foam and the comparatively low internal pressure of the tool.

The latter results in another advantage of the new manufacturing method: Whereas in the standard construction of foaming tools, sliders can only be used outside of the visible range, the risk of marking on the component during thin-wall foaming is considerably reduced by the lower process forces. The design of the tool used is thus much more flexible. In addition, a plant was selected for the thin-wall foaming whose beam geometry can be adapted to the respective component. This makes it possible to fill thin surfaces as well as deeper scoops without problems.

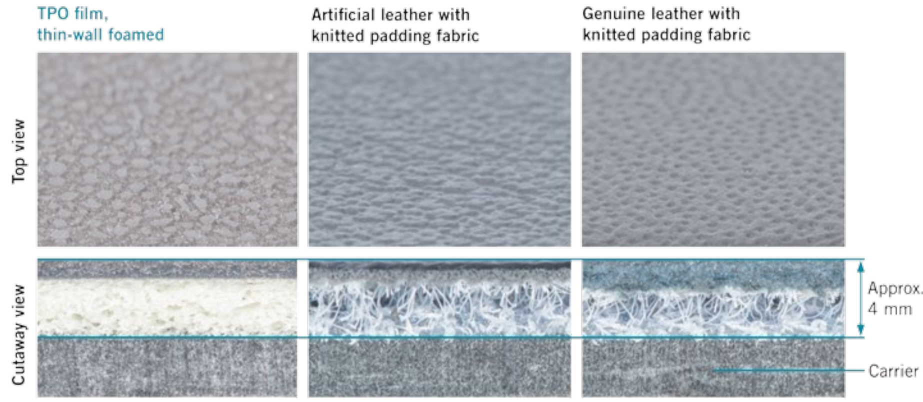

FIGURE 2 As the new thin-wall foaming uses material thicknesses similar to those of laminated leather surfaces with knitted padding fabric, the same carrier can be used for all standard materials in the premium automobile segment (© Jürgen Hofmann | Dräxlmaier)

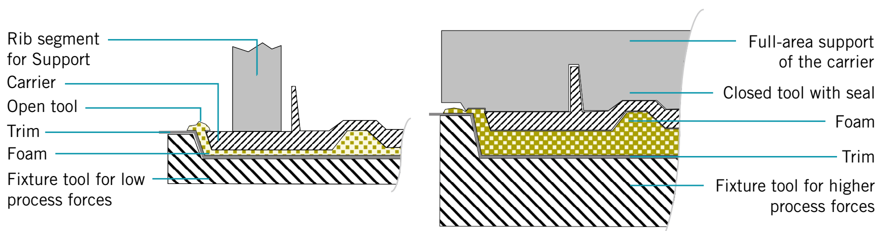

FIGURE 3 Simplified tool design with open sealing for new thin-wall foaming (left); standard construction with closed seal (right) (© Dräxlmaier)

LESS WEIGHT

Thin-wall foams, in addition to optimized process sequences and potential space savings, also have the advantage of saving weight: although the foam used has a slightly higher bulk density compared to conventionally used materials, the foam weight is reduced due to the particularly thin layer thicknesses which are now possible. An ideal saving effect is also achieved if the thin-wall foaming process is combined with high-quality and nevertheless particularly light surface films.

In the test, a component made in this way with a surface area of 0.63 m² was compared with a classic back-foamed PU spray skin: In this case, a saving of 248 g was possible in terms of the foam alone, which corresponds to a reduction in weight by 38 % compared to the standard method. Overall, the weight-optimized surface structure saves around 40 % of the total mass respectively 576 g, **TABLE 1**. Based on one square meter of component surface, this corresponds to a reduction of more than 900 g.

LIVING UP TO ALL EXPECTATIONS

Components produced using thin-wall foaming not only offer weight and construction space benefits, they can also offer impressive longevity: Weathering tests carried out according to OEM specifications, which simulate a particularly intensive long-term loading of the plastic surfaces, showed a high resistance in the materials used. Thus, even after the tests, the material properties were still within the established tolerance ranges. Accordingly, the thin-wall foaming process can be used in diverse applications.

	Standard foaming	Thin-wall foaming
Surface material	PU spray skin	Tepeo 2
Bulk density of foam [g/dm³]	170	215
Total thickness (trim with foam) [mm]	8-12	4.0
⌀ Wall thickness of the foam [mm]	6-10	3.0
Foam weight on the component [g]	654	406
Foam volume [dm³]	approx. 3.85	approx. 1.89
⌀ Thickness of the trim [mm]	1-2	0.9
Trim area [cm²]	6300	6300
Trim weight [g]	785	457
Trim weight with foam [g]	1439	863
Weight savings on the component [g]	0	576
Percentage trim weight with foam [%]	100	60
Carrier weight	neutral	neutral

TABLE 1 Comparison of selected material characteristics of a standard produced interior component with those of a variant produced using the thin-wall foaming process (© Dräxlmaier)

When used in the area of the instrument panel, the material must behave optimally in the event of the triggering of the front passenger airbag behind it, with regard to tear behavior and particle flight. For this purpose, the surface strength in certain areas is deliberately weakened. This cannot be seen from the outside in the finished component, for which reason the surface still looks like it comes from a single mold. Thus, both the optical and the functional demands of the premium vehicle segment can be completely met.

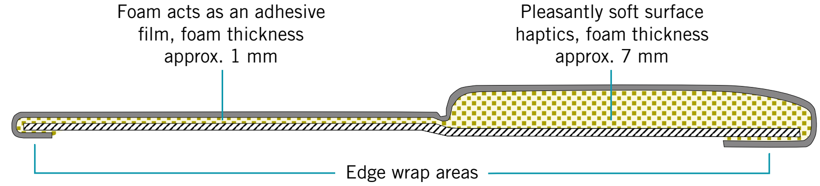

FIGURE 4 Due to different layer thicknesses, the thin-wall foaming method enables components with thin adhesive films or individual pleasant haptics (© Dräxlmaier)

EXTENDED FIELD OF APPLICATION

In addition to the benefits already mentioned, thin-wall foaming also offers the option of producing individual haptic profiles through different foam thicknesses from 1 up to 15 mm. In the thin-walled range, a foam thickness of about 1 mm is used like an adhesive film, whereas using a foam thickness of about 6 to 8 mm makes it possible to realize particularly soft areas, **FIGURE 4**. Due to its high variability, thin-wall foaming is thus also suitable for forming pleasantly flexible padding pads in the surface of the component – a property of the method which can already be used effectively in smaller components.

FUTURE IMPORTANCE OF THE INTERIOR

End customers can already choose today from various surface materials for their instrument panel and door panels. As the trend toward automated driving progresses, however, an even greater importance is given to the passenger compartment, since the attention of the vehicle occupants is shifted away from the traffic environment and toward the inside of the vehicle. In this case, the haptics of all surfaces within reach have a decisive impact on the quality impression achieved – and thus also on the well-being of the passengers. Methods that promise an increase in efficiency and quality in the production of high-quality interior materials are therefore becoming even more important than they are today. The fact that these objectives can be optimally achieved with the thin-wall foaming process developed by Dräxlmaier can now be seen in three series in standard production.