# Effective TPE processing with SmartFoam

Stieler
hall 10, stand J48

*Main uses for the nice material group of TPEs are soft protection, sealings, and parts with hand or skin contact. Warm feeling and soft-touch are properties that people associate with soft plastic. If you look around, you will see that TPEs make your life more comfortable; for example with tooth brushes, where often more than one component is TPE, car interiors, or machines for household and tools. The handles of nearly all hand drilling machines are covered with soft-touch TPE to get a good grip. Also most pens are supplied with a ring of TPE for easy handling and warm feeling at your finger.*

To achieve a good absorption level for protection products, many parts are made with thick sections of material. Those products are made with very soft resin types, most 30 to 50 Shore A. In the past there often have been concerns about products from China that used toxic plasticisers which migrate out of the product. On the other hand the very soft surfaces of the products often only have limited resistance to friction. The abrasion by dynamic friction therefore reduced the life time of these products dramatically.

## Need for a new process technology

To solve these problems Ulrich Stieler developed equipment and process technologies for extrusion lines to produce physically foamed coax cables and small sealing stripes for furniture. At the same time he developed hollow parts produced with gas and fluid-assisted systems. Initial trials with an arm rest for an office chair with gas-assisted technology instead of chemically foamed resin were successful: a better surface, light weight, short cycle time, and low distortion have been achieved. But after assembly of the modified product the customer sat on the chair, knocked on the arm rest and said: "This is nice, cost-effective and good in measurement, but it sounds hollow, that means cheap." And so the need for a new process technology was born.

Fig. 1: Gear shift knob

Stieler found the solution while working on another project. The specification here: to produce a gear shift knob with a compact high quality skin, a soft-touch and leather-like feeling on the surface, soft-touch from inside, and resistance to different media. This was the time when the **Stieler SmartFoam** system, a new physical foam process was developed **(figs.1, 2).**

## The principle of the Smartfoam system

The challenge was to develop the right nozzle and mixer systems and also the controller for the high speed SmartFoam fluid process. The principle of the system – a combination of sandwich moulding and gas-assisted moulding – is simple at first sight, but processing this system requires a deep understanding of the physics of injection moulding and fluid systems.

Melt is injected into a mould on a one-component injection moulding machine for a definitive amount. During injection phase the SmartFoam fluid like nitrogen, water or liquid $CO_2$ is added to the feed and mixed just before the gate. After the first amount of melt has build-up a skin at the cold mould surface, the mixture of melt and fluid in entering the cavity with easy flow and expands quickly. The first amount of melt will sort out the compact surface image without contact to any foaming agent. The melt-fluid mixture is expanding and filling the mould core quickly and without any back pressure. No flash in the trimming line is expected, no high clamp force is needed. The amount of melt, the heat and cooling energy are almost 20 – 30 % less compared to the compact volume. The expansion of the foam bubbles inside the cavity cools the mixture from inside of the product and presses the skin outside into the cooling mould surface.

Low stress, short cooling time, low clamping force and natural and the use of physical foaming agents are the big benefits of the SmartFoam process which could run on every single injection moulding machine. The SmartFoam technology will be applied and modified in the hot or cold runner only.

If liquid $CO_2$ is used for the SmartFoam process, the expansion cooling energy by transfer from the liquid into the gas-formed phase is 40 times bigger than water. This is the reason, why the product inside is already cooled-down while the skin outside must be cooled by the mould. No other process could achieve such a cycle time reduction with a nearly compact product design.

During expansion of the fluid the resin is quickly cooling developing thin closed mem-

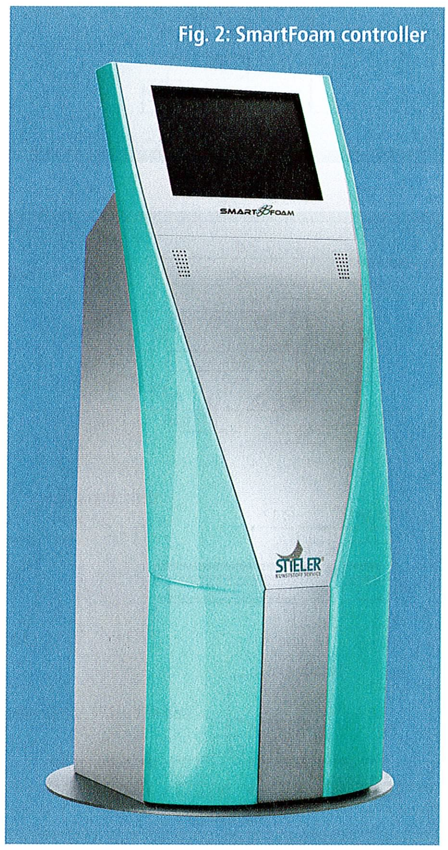

Fig. 2: SmartFoam controller

brane structures like thousands of bubbles. This means that absorption energy is taken by the pressurised bubbles and reacts into further contour very quickly. The use of the Smartfoam results in a soft core and therefore the moulder is able to use for example a grade of 70 Shore A instead of a 30 Shore A. The skin of the part is hard and durable, abrasive resistant, easy to keep clean and has no rubbery surface. No plasticiser is needed and the part is produced with economic efficiency fully recyclable.

Chemical foaming agents have the major disavantages that they heat up the product from inside over a long time and can migrate onto the surface. These migration particles are not UV-resistant and will lead to discolouration, or even will foam up again under

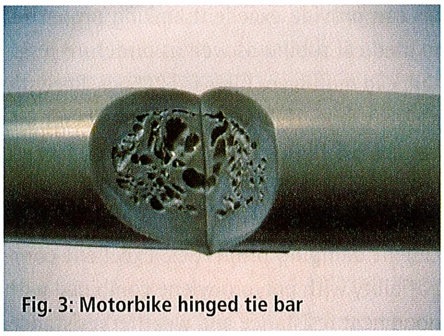

Fig. 3: Motorbike hinged tie bar

UV exposure if the product were lacquered. The mould surface must also be protected against the chemical agents.

Big parts like fenders produced with the SmartFoam process are more stable, because the internal closed cell foam structure will not let water from outside into the product, even when the compact outer skin is damaged by cutting, etc.

## Structures like human skin

SmartFoam structures are like the skin of humans; outside a very thin and resistant skin and underneath the soft structure. Therefore the process is especially suitable for the production of parts like TPE pacifiers for babies for example. Nature was used as archetype for the SmartFoam process also in the processing of hard resin types like glass-filled polyamide, where the structure of those products are bone-like with highest bending stiffness.

As shown in the pictures the skin of the parts produced with the Stieler Smart Foam system is always compact **(fig. 3).** A good example is the sealing of a plastic cork stopper, also a novel product of Stieler **(fig. 4).** Thanks to its closed cellular structure and its internal pressure the cork stopper returns to its initial size after milliseconds – that means no leakage at the bottleneck when the bottle is laid to storage. A chemically foamed cork must be produced in a higher Shore A grade, because the internal structure is like a sponge and takes some time to get back into its initial form.

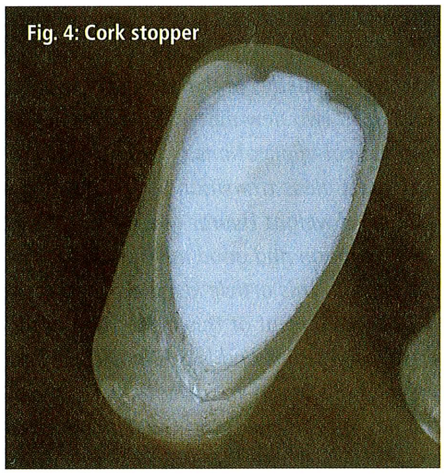

Fig. 4: Cork stopper

Ing. Ulrich Stieler
Managing Director
Stieler Kunststoff Service, Goslar, Germany
stieler@stieler.de