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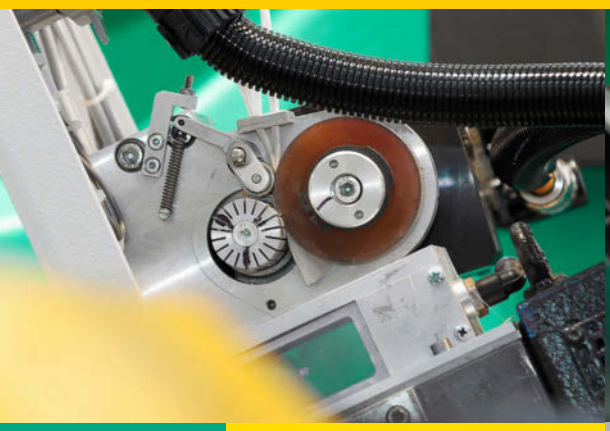


Injection moulding of lightweight parts

Less weight thanks to solutions with multi-material design

ARBURG

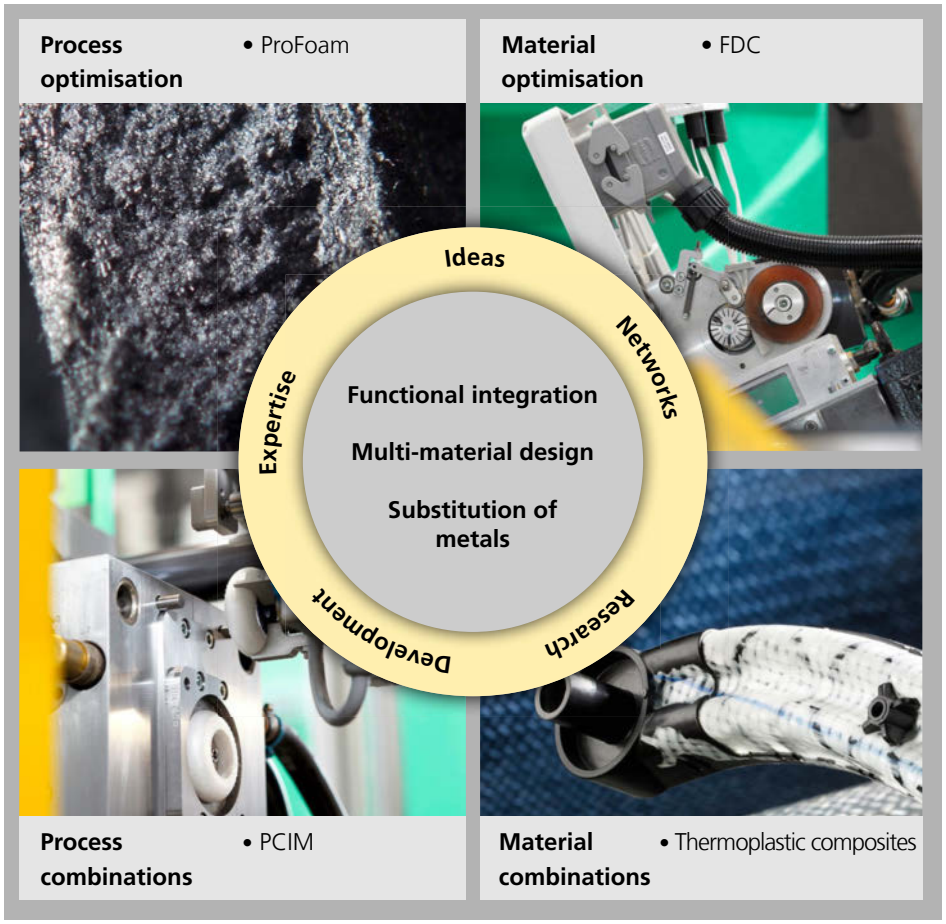
www.arburg.com

At a glance

Huge potential: sustained rises in fuel prices and the continued limitations in the range of electric drives mean that lightweight construction is key in areas such as transport logistics.

Cost savings, increased efficiency, conservation of resources and lower CO_2 emissions: Lightweight construction is seen as a "problem-solver" in many sectors - from transport and logistics, medical and packaging to building technology. The aim is to reduce part weights, while maintaining or improving mechanical properties or replacing metals. Innovative injection moulding processes are required for this purpose. Acting jointly with a network of expert partners and cooperating closely with universities, ARBURG is constantly developing new solutions for the injection moulding of lightweight parts. The range extends from function-specific product design and the modification of processes and plastics, through to multi-material design. This results in processes and additional equipment ready for high-volume production combined with a high level of consulting expertise.

Lightweight construction: task involving a variety of possible solutions.



Example from the automotive industry: ALLROUNDER injection moulding technology, together with our expertise, are continuously opening up new application areas for lightweight plastics.

Recognition of potential and knowledge of processes

Lightweight construction always gains enormous potential whenever products offer the same or greater resilience in practical applications despite their reduced weight. This enables significant cost savings to be achieved during production, as well as in the daily use of lightweight parts. Other advantages include the replacement of classic materials and efficient batch production. Whether thermoplastic foaming, integrated fibre reinforcement or in combination with other materials such as thermoplastic composites and particle foams: ARBURG is familiar with the potential savings and the limitations of the various processes.

Designing technology with a specific process in mind

Universal ALLROUNDER injection moulding technology can be adapted to different lightweight construction processes using appropriate additional equipment. In-house developments have been produced through intensive cooperation with partners who have the necessary specific technical expertise. The mostly complex production processes are managed with upstream/downstream processing steps, precise injection moulding and detailed quality monitoring via the powerful SELOGICA control system.

In-depth consultation

The injection moulding of lightweight parts is a complex matter that requires extensive technical expertise in a variety of areas. That is why ARBURG has formed partnerships in various networks that focus on the optimisation and combination of processes or materials. This means that it will be possible to extend our knowledge, for example regarding the best way to benefit from technical or cost advantages. This will enable ARBURG to offer its customers comprehensive advice on specific technical applications, as well as the corresponding technology.

Process optimisation: the ProFoam foaming process

Foaming glass-fibre reinforced plastics:
with ProFoam without additional shearing.

Lightweight construction for weight reduction

ProFoam can be used to produce fine cell structures in the part, efficiently reducing the amount of material used. The required gas-filled plastic compound is produced on conventional injection moulding machines with little additional technical effort and without additional peripheral equipment. The feed hopper is replaced by a patented granulate lock for the continuous feed of material and gaseous blowing agent, while the injection unit is equipped with a needle-type shut-off nozzle and additional seal. This produces a propellant atmosphere in the granulate feed. The granulate and the melt are thereby mixed with the gas required for foaming. The prevailing temperatures in the injection unit and the conventional three-zone plasticising screw cause the propellant to dissolve homogeneously in the melt.

Joint research and further development of the ProFoam process conducted by the IKV and ARBURG make it easier and more efficient to exploit the advantages of thermoplastic foam injection moulding.The plastic granulate is mixed with a gaseous blowing agent (N_2 or CO_2) in a granulate lock upstream of the injection unit. In this way, lighter moulded parts can be produced, saving material. However, this also minimises sink holes, as well as shrinkage and distortion. An additional benefit: fibre-reinforced plastics are processed without additional shearing.

Hybrid/hydraulic ALLROUNDER H/S machines	
Distance between tie bars:	270 mm - 630 mm
Clamping force:	350 kN - 2,500 kN
Injection units:	170 - 800 with medium screw diameters

Example

New foaming options

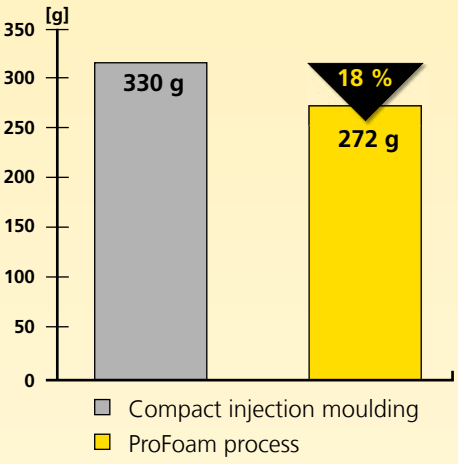
The ProFoam process offers further interesting advantages in addition to simple and efficient foaming technology:

- Flexible use: the machines can be used for conventional compact injection moulding without limitation.
- Simple process control: it is only necessary to consider one additional setting parameter for propellant pressure.
- Normal screw geometry without a mixer: no additional shearing of fibre-reinforced plastics.
- Homogeneous foam structure

Airbag housing

- Material: PP-LGF (long fibre granulate)
- Part weight: 272 g at 280 mm length
- Cycle time: 70 s

The thick-walled housings are manufactured from fibre-reinforced plastic. The use of the ProFoam process achieves a permanent reduction in sink holes, shrinkage and distortion. At the same time, material consumption is reduced. The result is an efficient production process which enables high part strength at low unit costs:



Optimising materials: Fibre Direct-Compounding

FDC unit: Cutting and inline feeding of fibres into the liquid melt.

High-strength lightweight construction

In the FDC process, fibres are fed directly into the liquid melt. This achieves greater part resilience and reduced wall thicknesses. The FDC process offers new opportunities and interesting advantages over long fibre granulates:

- Targeted influencing and optimisation of mechanical component properties
- Detailed process settings are possible, e.g. fibre length and fibre proportion
- Longer, individually cut fibres can be fed in
- Less damage to the fibres when the melt is prepared
- Use of inexpensive base materials
- Reduction in material costs – by up to 45 percent

The longer the fibres in the part, the better the part's mechanical properties. Until now, the processing of longer fibres failed due to limitations in material preparation and dosing or due to the granulate form. The Fibre Direct Compounding process jointly developed by ARBURG and the Plastics Centre of Southern Germany (SKZ) involves cutting continuous glass fibre strands and feeding them directly into the liquid melt. The result is a cost-efficient production process that also opens up new opportunities for reinforcing plastics.

Hydraulic/electric ALLROUNDER S/A machines	
Distance between tie bars:	520 mm - 920 mm
Clamping force:	1,500 kN - 5,000 kN
Injection units:	800 - 4600 with minimal screw diameters

g (FDC)

Integrated fibre reinforcement

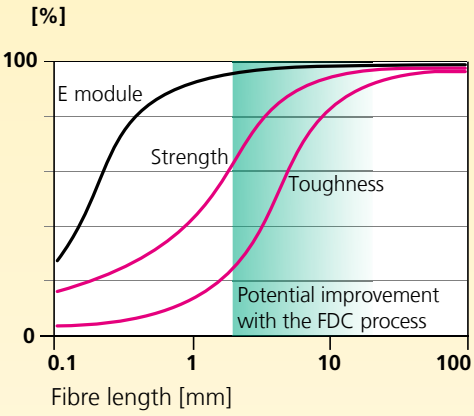
The aim when developing the FDC process was integrated fibre reinforcement at lower unit costs. A servo-electric FDC unit cuts continuous fibre strands into 15 to 50 mm lengths and adds them directly to the liquid melt. A two-stage screw is used to homogenise the fibres and melt in a special cylinder module. Separate symbols enable the FDC process to be programmed easily and flexibly. In addition, the SELOGICA control system also uses the signals of the FDC unit to monitor quality. Its enclosed construction means that the FDC unit can be quickly reconfigured, so that it has universal applications. An additional thermoplastic cylinder module means that the ALLROUNDER machines can also be used for conventional injection moulding.

Example

Test plate

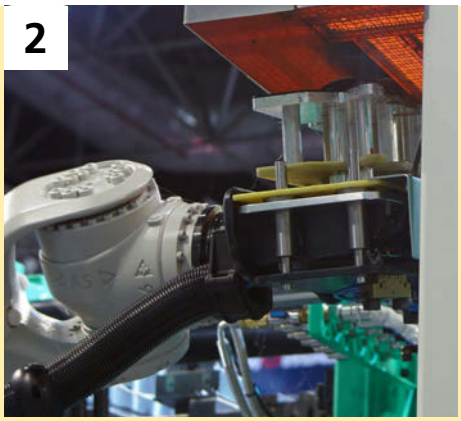
- Material: PP + Glass-fibre roving
- Part weight: 300 g at 500 mm length
- Cycle time: 58 s

Tests such as pre-ashing a test plate (in the background in the photo) provide the evidence: The FDC process enables long fibres to be incorporated in injection moulded parts, permitting targeted reinforcement. Clear potential exists to improve the mechanical properties of the parts. However, the FDC process is a complex task, which requires specialised know-how and a holistic solution approach: from the correct design of the component and technology through to process configuration. In order to provide in-depth consulting to customers for this purpose, ARBURG has the appropriate experts in its Applications Technology department.

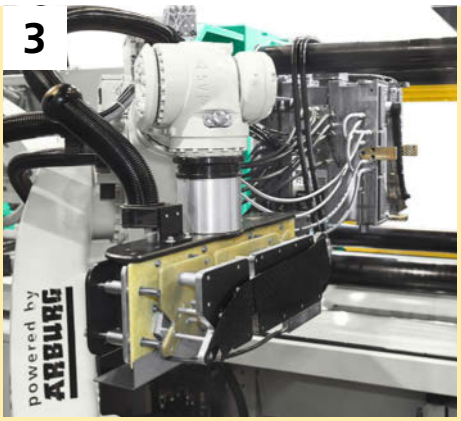


Combining materials: Thermoplastic composites sh

Step 1: A robot picks up the thermoplastic composite sheets and warms these in the gripper.

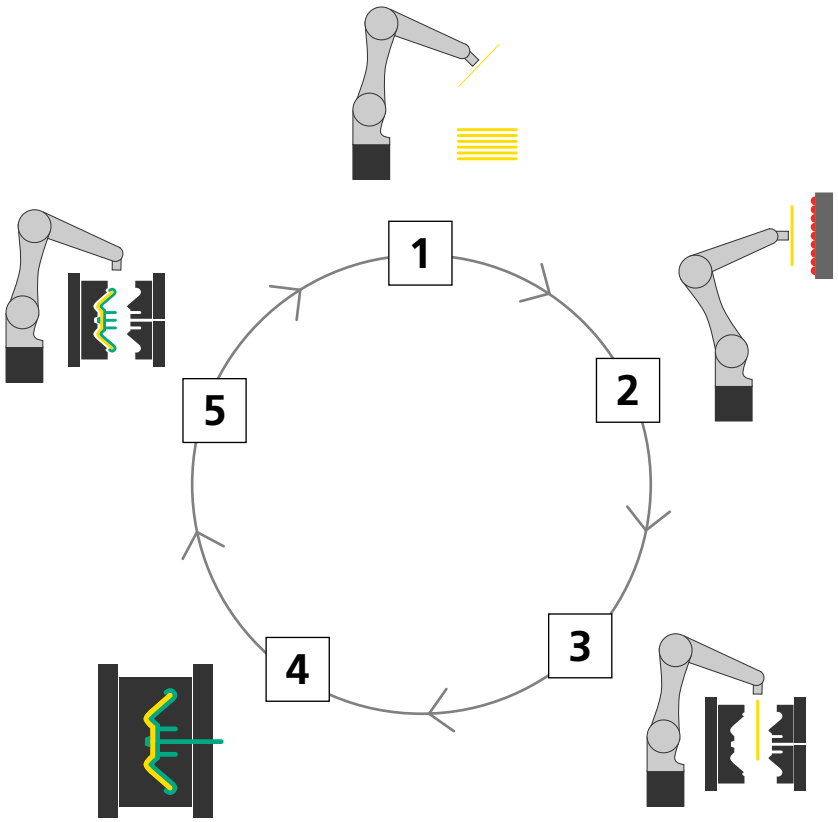


Step 2: IR heaters heat the thermoplastic composite sheets to forming temperature.



Step 3: The robot places the thermoplastic composite sheets in the injection mould.

A combination of injection moulding and thermoforming of thermoplastic composites can further enhance the strength of fibre-reinforced moulded parts. The integration of additional reinforcements by means of ribs or functional elements such as mountings produces highly resilient, installation-ready products. This makes it possible to replace conventional materials such as metals in many applications. The overmoulding of thermoplastic composite sheets is a process with enormous potential for the future One keyword is enough to demonstrate this: Electromobility.



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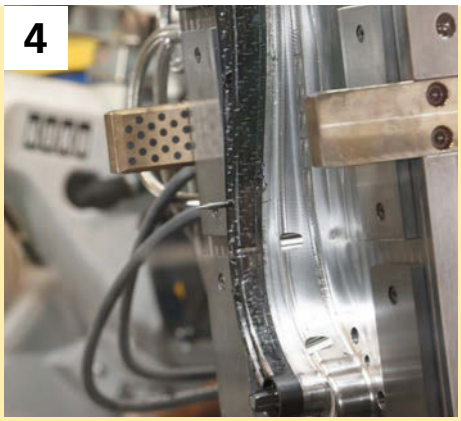


Step 4: Thermoplastic composite sheets are thermoformed and overmoulded.

Step 5: A robot removes the ready-to-install structural parts.

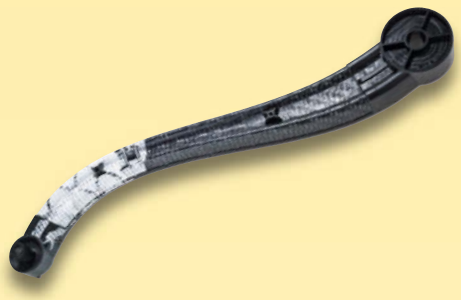
Lightweight construction with multi-material design

The substitution of metals in lightweight construction brings particular benefits when glass-fibre reinforced plastics are used. Thermoplastic composite combine two or more materials in a targeted approach, resulting in the mutual enhancement of their mechanical properties. The continuous fibres, usually glass, carbon or aramide in woven or non-woven form, improve strength and rigidity. The matrix material is responsible for the transfer of force between the fibres in the composite and protects the reinforcing structure from buckling or environmental influences. In general, parts made from thermoplastic composites weigh between 30 and 50 percent less than those made from metal of the same thickness and with similar mechanical properties. This enables the design to be thinner, more rigid and stronger.

Important: Fully automatic process

The overmoulding of thermoplastic composites involves the manufacture of composite fibre lightweight parts suitable for batch production in a fully-automated process. Injection moulding turns thermoplastic composite sections into ready-to-install, high-strength structural components. This process is ideal for high-volume applications, as the cycle times that can be achieved are the same as with injection moulding. Another advantage is that it can be combined with other processes, such as the FDC process. This gives rise to a wide range of options, for example in the areas of part design or function integration.

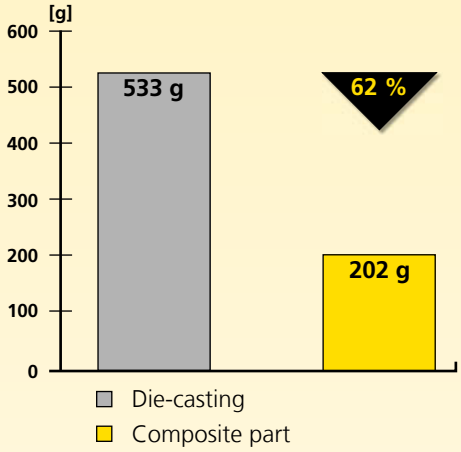
Example



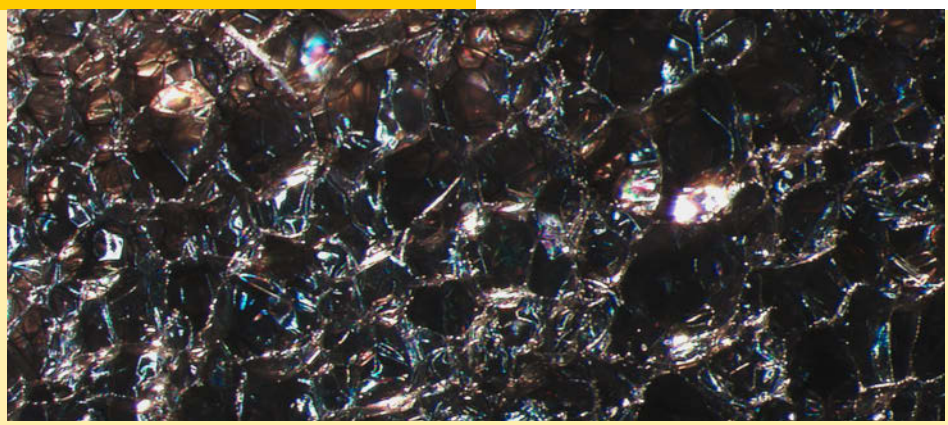
Demonstration lever

- Material: PP + Glass-fibre roving + Thermoplastic composite sheet
- Part weight: 202 g at 500 mm length
- Cycle time: 40 s

The demonstration lever can be used as a swing arm for a bicycle or as part of the seat structure in cars, for example. The part consists of two thermoplastic component sheets of different thicknesses. These are shaped in a LIPA (Lightweight Integrated Process Application) mould and, at the same time, functional and reinforcement elements are added using the FDC process. The result is a high-strength, lightweight composite part with the potential to replace a metal part.



Combining processes: Particle-foam Composite



Lightweight, impact absorbent, insulating: the cell structure of particle foams offers interesting properties for many applications.

Positive bond: ideal for high loads

With Particle-foam Composite Injection Moulding,® a foamed moulded part is permanently bonded to plastic. This allows the positive properties of particle foaming such as EPP or EPS to be combined with ther moplastics such as ABS, PP or TPE. The unique combination of materials extends the functionality of components considerably and offers your product developers scope to develop completely new application ideas. Together with our project partners Ruch Novaplast and Krallmann, we are using this process to open up new and unfamiliar opportunities in lightweight construction.

Lightweight construction with functional integration

As the plastic is injected into the mould, the surface of the expanded polypropylene (EPP) or polystyrene (EPS) melts in a defined way: a strong, permanent, positive bond is created between the two components. The composite parts are produced in a single step. This means integrated functionality without downstream assembly. The ideal conditions for cost-effective series production at reduced unit costs.

The multi-material design involving particle foam and thermoplastic eliminates the weaknesses of both materials and unites their advantages for lightweight construction, such as:

- Stable lightweight cladding panels
- Energy-absorbent handles with an attractive tactile surface
- Thermally insulating covers with integrated attachment functions
- Noise-reducing, easy-to-assemble housing
- Insulating products with enhanced rigidity

Particle-foamed part	Plastic part
+ Low volumetric weight + High force absorption + High thermal insulation	- Relatively high volumetric weight - Low force absorption - Low thermal insulation
- Limited surface - Limited attachment options	+ Functional surfaces + Wide range of attachment options

Injection Moulding® (PCIM)

Compact production cell: Six-axis robotic system links foaming system and ALLROUNDER.

Special: Material mix and know-how

Particle foams have a density of between 20 and 60 grams per litre. The foamed moulded parts produced on special foaming systems are thus correspondingly light. To ensure that these can be safely placed inside the mould and then overmoulded without deformation or damage, special expertise and special technology is required:

- A specially coordinated mix of materials and an appropriate programme for the combination of both materials
- Precise particle-foam inserts with high-contour accuracy
- Near-contour, segmented mould temperature control
- Specially designed sprue system
- Reliable handling and precise positioning of foamed inserts by means of a robotic system
- Precisely regulated, multi-stage injection process
- SELOGICA control system integrates entire peripherals for individual process control

Example

Standardised fastening elements

- Material: EPP + PP
- Part weight: 2.85 g
- Cycle time: 38 s

The standardised fastening elements of the K-Fix series from the Krallmann Group can now also be integrated into foamed housings or panels of the NOVAFeed&Fix series from Ruch Novaplast, for example. This makes it possible to produce sealing systems for cables and sensors, as well as for heating, air-conditioning and ventilation equipment, water-collecting systems and easy-to-install insulating panels.

Distances between tie-bars up to 920 x 920 mm | Clamping forces up to 5,000 kN | Injection units up to 4600 (according to EUROMAP)

Film

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