PET Foams Lightweight Cores for Strong Structures



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Armacell – a global market leader and pioneer in sustainability

Climate protection and sustainability are shaping the political agenda worldwide. Embracing responsibility for future generations means to focus on the need for sustainable construction using materials and structures which offer long-term performance. Buildings today are responsible for more than 40% of global energy consumption and account for 1/3 of the greenhouse gas emissions into our planet's atmosphere. By observing environmental needs more carefully in building planning and construction, decision makers at all levels can promote the transformation of our building environment towards greater energy efficiency and climate friendliness.

This is second nature to Armacell. Since our company was founded back in 1860 as Armstrong Cork, we have been serving markets with products that promote sustainable building concepts. But also in internal procedures, environmental stewardship is a day-to-day concern. Every industrial company has an unavoidable impact on the environment; our operating principles prescribe that we reduce that impact to a minimum. Combining this legacy with decades of research and experience in polymeric foaming have made us what we are today, a leading innovator in our markets and a pioneer in sustainability.

Facts and Figures

The company: Armacell International S.A.

Founded: In 1860 the first activity started of Amacell's former parent company Armstrong Cork, which later became Armstrong World Industries. In 2000 Armstrong's insulation product division becomes independent under the name of Armacell.

Total net sales (2017): 603.2 million euros

Headquarters: Capellen (Luxembourg)

Global presence: 3,000 employees, 27 production plants in 17 countries

Established brands:

- ArmaForm[®] (PET foams, which are used as a core material in sandwich constructions)
- Armaflex[®] (highly flexible, closed-cell elastomeric insulation)
- Tubolit[®] (thermoplastic pipe insulation)
- OKA[®] products (covering systems made of PVC and metal)
- Arma-Chek[®] (highly flexible, non-metal cladding system)
- ArmaSound[®] (acoustic insulation products and systems)
- Ensolite[®] (closed-cell foams in continuous rolls)
- Monarch[®] (microcellular block foams)



ArmaForm[®] – the reference for PET foam core technology

ArmaForm is a continuation of this success. Our innovative, energy-efficient structural PET foam cores for the composites industry are manufactured according to a resource-optimised production process. ArmaForm is fully recyclable and – more importantly – is made out of 100% recycled products. Armacell scientists have dedicated years to developing production technologies

and special recipes that allow a stable production process using post-consumer PET packaging waste as raw material to produce ArmaForm. It is not only green in color, it is a truly sustainable solution. The Life Cycle Inventory Study (2011) results show that for every pound of recycled PET flake used, energy use is reduced by 84% and greenhouse gas emissions by 71% ¹).

¹⁾ Life cycle inventory of 100% post-consumer HDPE and PET recycled resin from post-consumer containers and packaging Franklin Associates, January 2011.



Our PET foam product range

ArmaForm[®] Core

Structural lightweight PET foam cores made of 100% recycled PET.

ArmaForm® MultiCore - combines different densities in one foam core, improving impact and point load resistance, keeping the weight to a minimum.

ArmaForm® Eco - combines strength, stiffness and thermal insulation with process versatility, design flexibility, and outstanding sustainability.

ArmaForm[®] Foil

The first fully recyclable and thermoplastic foil product, entirely made of recycled PET, with an outstanding operating temperature window. Designed for thermoforming applications and sandwich structures with very thin cores.

ArmaShape

Loose PET beads for large-scale production of ready-to-use 3D shaped foam cores. The high mechanical properties of structural foam cores combined with the advantages of particle foams offering a lightweight but strong product, producable in any shape.

The sandwich concept



A sandwich structure consists of two relatively thin, yet strong and stiff, skins or facings on both sides of a thick, yet lightweight, core material. The skins take up the normal stresses in-plane and give the structure a hard-wearing surface. The core material absorbs the shear forces generated by out-of-plane loads, distributing between the skins and spreading them

over a larger area, while maintaining the skins at a fixed distance.

The result is a greatly improved bending strength and rigidity compared to monolithic materials. If you double the core thickness further, the weight increase is negligible, while the stiffness is multiplied by a factor of 4 and the strength is doubled.







Unique characteristics of ArmaForm[®]Core



Superior mechanical properties, excellent compression strength and high shear modulus.



Outstanding fatigue resistance (threshold > 60%) for maximum lifespan.

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Easy to shape by thermoforming (3D), offering freedom in design.



Easy to process with most types of resin and production methods.



High processing temperature of + 150 °C / + 302 °F with short term curing temperature up to + 180 °C / + 356 °F.



Excellent thermal insulation properties.



Closed-cell structure means **extremely low water and resin absorption** (no corrosion and degradation over time).



Good screw retention.

100% recyclable.

Please find technical data sheets for download as well as further information on our website: www.armacell-core-foams.com.

Your benefits with ArmaForm® as core material

Compared with other plastics such as PVC and PUR/PIR, ArmaForm is easier to recycle, extremely resistant to temperatures, in combination with excellent fatigue properties.



Stability and lightweight mean new possibilities

In an ever more complex world with fierce competition for market share, the demand for efficient products is increasing exponentially. Most of the current growth is driven by substitution. New and better products replace existing solutions. Openness to new concepts, speed of implementation and the willingness to innovate are indeed factors that set successful companies apart from those who are merely followers. Sandwich composites belong to the category of products with a huge substitution potential. It is mainly due to weight savings that they are becoming more and more popular in structural design. There are other benefits prompting design engineers to take a closer look at sandwich composites: Low maintenance and repair costs, positive environmental aspects, ease of installation, design flexibility and low thermal conductivity. These factors will have a greater or lesser impact, also depending upon the strategic choice of the right core material. And that is where ArmaForm comes into play, offering tremendous benefits to a broad area of applications in Wind, Building & Construction, Transport and General Industry.

Wind Energy

Wind Energy is faced with the challenge of achieving grid parity. This requires more effective components at a lower cost. A challenge difficult to meet. Since qualifying our first ArmaForm products for wind turbine blades, we have continued to innovate in the development of PET foam and will never rest in improving our own production efficiencies. Supporting the OEMs in their endeavour of delivering clean energy at an acceptable cost to the world, we have always shared efficiency increases with our partners and consistently improved our overall value proposition. 100% supervised quality; superior fatigue properties and excellent strength to weight ratios are just a few examples, besides attentive customer service, that have made Armacell the supplier of choice for leading players in this industry.

Rotor Blades / Nacelles / Spinners / Housing

Transport

Used as a core material in composites, ArmaForm helps to reduce the weight of rail and road vehicles by up to 50%, compared with conventional metal components, thus reducing fuel consumption and carbon emissions. Because of their excellent water resistance, all ArmaForm foam cores are perfectly suited for boat and ship building applications. Screw retention is an additional key benefit for all markets. ArmaForm meets the most relevant international fire and smoke regulations for rolling stock, as well as for the aviation market.

Rail & Road and Aviation: Body Structure / Interior Panelling / Floors / Roofs / Cabin Modules

Marine: Boat Hulls / Cabin Interior / Decks / Superstructures / Furniture

Building and Construction

Buildings are made to provide shelter. But they also shape the landscape around us. Thermal formability is just one benefit of ArmaForm in sandwich composites, allowing exceptional freedom of design for architects. Other benefits like low thermal conductivity, ease of installation, light weight and long free spans, the possibility of combining with all types of decorative surfaces, no corrosion and low maintenance and repair cost, make ArmaForm in sandwich composites a preferred choice for architects and engineers to substitute with existing building materials.

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Roofs / Facades / Domes / Bridges / Radomes

General Industry

ArmaForm is ideal in any scenario where sandwich elements can save money thanks to low weight, easy workability, low maintenance and high durability. An early discussion with our specialists can help to improve your design – and save money. We are happy to assist.

> Water & Chemical Tanks / Food Trolleys / Shower Pans / Industrial Ventilator

> > @armacell

Environmental Protection and Corporate Social Responsibility

The insulation of technical equipment in buildings and industry is one of the simplest and most efficient ways of saving energy and reducing CO_2 emissions. As a world leader in flexible insulation foams for the equipment insulation market as well as a leading provider of engineered foam products that have been installed in millions of buildings and facilities around the globe, Armacell makes a considerable contribution to abating greenhouse-gas emissions.

Environmental Commitment

Besides making an important contribution to environmental protection by manufacturing energy-saving products, Armacell practices active environmental protection throughout the company.

Environmental protection is one of the main pillars of Armacell's corporate philosophy. It is an integral part of the business strategy and ranks equally with other company objectives. The environmental guidelines oblige all Armacell employees worldwide to aim to protect the environment and conserve natural resources.

To use resources as efficiently as possible, Armacell is constantly searching for ways to reduce raw material use, energy consumption and waste. Intelligent systems have been developed to utilise production waste. The majority of locations are certified in accordance with the international environmental standard ISO 14000 – and all European plants are already certified today. Armacell is also a founder member of the European Industrial Insulation Foundation (EiiF), whose purpose is to promote the use of optimised insulation systems in industrial plants.

Armacell became in 2009 the world's first manufacturer of flexible technical insulation materials to present a comprehensive ecobalance life-cycle assessment (LCA).

Social Commitment

In recent years, Armacell has also been emphasising the social dimension of sustainability to its management and employees. In 2005, Armacell received the Ethics in Business Award for its outstanding commitment to environmental and social issues. In 2006, Armacell joined the UN Global Compact initiative, the world's most important business network for sustainable globalisation. As a company with a global footprint, Armacell supports local good citizenship projects. In 2011, the company adopted a specific code of conduct that obliges all employees worldwide to act ethically. The Armacell Code of Conduct is based on values and principles that apply throughout the Armacell Group.

Armacell's Environmental Protection Guidelines

Our aim is to gear all our business activities towards protecting and conserving nature. Our environmental policy is based on the following principles:

Manufacturing only products that pose no risk to the environment when they are used as intended by customers and consumers.

Supplying information on the correct storage, use and disposal of our products.

Conserving natural resources by using raw materials and energy responsibly.

Using environmentally-friendly technology in research and production. By doing so, we increase safety in the workplace and protect our communities and the environment.

Avoiding and reducing waste; using recycling and environmentally-friendly disposal systems.

Reducing risks to soil, air and water to the greatest extent possible

Preparing for potential dangerous situations in order to protect both people and the environment.

ArmaForm[®] a truly sustainable concept

"Caring for Climate", a UN Global Impact Initiative, highlights the responsibility of businesses to reflect the needs of climate protection. A principle we have fully endorsed as well in our PET production: the product is fully recyclable, we re-use 100% of our material process loss in internal recycling, and we do not use any ozonedepleting HFH or CFC blowing agents.

But we did not stop here and have made again a significant contribution to sustainable growth: Scientists of the global R&D Team of Armacell have spent several years to develop a technology that enables the production of PET foam boards in consistent, reliable qualities made 100% from postconsumer PET packaging materials (r-PET). While "cradle to cradle" recycling of PET bottles is common practice and r-PET bottles are considered a valuable raw material, Armacell has developed the capability to recycle a PET packaging waste stream, which to a large degree ends up on landfills or goes to incineration, but it is now used to produce ArmaForm.

Making the post-consumer r-PET requires 70% less energy and produces 80% less CO_2 per unit than the virgin PET resin¹). Using such r-PET as a raw material for our foaming process, a 34% reduction of the carbon footprint is possible compared to the use of virgin PET resin. The results of comprehensive LCA review ²) are depicted in the chart below indicating the relative greenhouse effect (CO₂ emissions) of various foams, including that of ArmaForm made of r-PET ³).







¹⁰Life cycle inventory of 100% post-consumer HDPE and PET recycled resin from post-consumer containers and packaging Franklin Associates, January 2011.

² Armacell LCA report, data from 2015. ³ SimaPro Database 7.3.0; method: CML 2001

Complete monitoring for 100% safety

Our products and processes reflect the highest quality standards for products and services in line with ISO 9001:2015. We use state-of-the-art technology for production, control and monitoring in the ArmaForm manufacturing process. For instance, we have implemented fully integrated ERP and Six Sigma process monitoring systems, which enable full 100% quality control of important product properties relevant to the reliable performance of a sandwich composite:

I Challenge No. 1: Density variation

The mechanical properties are all related directly to the density of the foam core. The physical properties of the sandwich panel thus depend on close density control of the core.

The ArmaForm Solution:

Density variation is kept at a very low level (< 5%), because ArmaForm production features 100% in-line control. Monitoring density information continuously and using that information to adjust process parameters, prevents failures of the sandwich due to uncontrolled density variations.

I Challenge No. 2: Thickness variation

Stiffness is an important characteristic of a sandwich composite that increases exponentially with the thickness of the core material. Small variations in core thickness already have a big impact. Reliable performance of the sandwich depends heavily on compliance of the delivered core material board thickness with the requirements as calculated and requested by the design engineer.



Additionally, thickness variation in the interface between two core sheets could result in local buckling or kinking of the sandwich face sheets.

I The ArmaForm Solution:

Automated, 100% in-line control measures every single board to ensure the precise thickness tolerance range.

Challenge No. 3: Surface damage or impurities

Surface damage and impurities can lead to delamination of the sandwich skin and subsequent blistering in and failure of the sandwich panels.

I The ArmaForm Solution:

All individual boards are subjected to in-line optical scanning. Screening the foam core sheets for surface damage and impurities ensures reliable adhesion between the foam core and the FRP laminates and prevents failure of the sandwich elements. When the system is outside the specified tolerances, the slicing line stops and an operator has to intervene.

The final product is continuously compared against the original approved material, including visual inspection and packaging requirements. Above and beyond these in-line measurements and inspections, a series of additional tests are performed regularly to guarantee the utmost quality and reliability.

Unique: 100% traceability

Every single **ArmaForm** board produced is identified by a unique barcode. This allows the traceability from the final product to the raw material used to manufacture that product. It is also possible to access the archived parameters of the entire product process, simply by scanning the barcode.



Convenient PET foams solutions worldwide



There are not always standard solutions when it comes to using GRP Composite Sandwiches with whatever kind of core material. Simply share with us your project ideas and we will guide you on how it can be done. We will gladly work with you to develop a concept that offers you all the benefits of this innovative foam core material and fulfils your particular industry requirements, worldwide, no matter where you are.

Thanks to our close network of partners in all aspects of the composite industry, from engineering and design to converting and manufacturing, we guarantee you a project involving close consultation and support - exactly the way you need it.

We'll show you what's possible. Simply ask.



All data and technical information are based on results achieved under the specific conditions defined according to the testing standards referenced. It is the customer's responsibility to verify if the product is suitable for the intended application. The responsibility for professional and correct installation and compliance with relevant building regulations lies with the customer. Armacell takes every precaution to ensure the accuracy of the data provided in this document and all statements, technical information and recommendations contained within are believed to be correct at the time of publication. By ordering/receiving product you accept the Armacell General Terms and Conditions of Sale applicable in the region. Please request a copy if you have not received these.

As the inventors of flexible foam for equipment insulation and a leading provider of engineered foams, Armacell develops innovative and safe thermal, acoustic and mechanical solutions that create sustainable value for its customers. Armacell's products significantly contribute to global energy efficiency making a difference around the world every day. With 3,000 employees and 25 production plants in 17 countries, the company operates two main businesses, Advanced Insulation and Engineered Foams. Armacell focuses on insulation materials for technical equipment, high-performance foams for high-tech and lightweight applications and next generation aerogel blanket technology. For more information, please visit: www.armacell.com.

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