WHITEPAPER

Polyolefin-Based Flooring as a Sustainable Alternative to PVC

Polyolefin (PO)-based flooring represents an alternative material solution and complements existing material systems in the market. In the context of increasing regulatory requirements and growing sustainability demands, circular materials are gaining importance. PO systems provide functionality comparable to polyvinyl chloride (PVC)-based solutions, with advantages in terms of emissions and recyclability.

Introduction

The market for resilient flooring is among the fast-growing segments of the construction and interior design industries and is driven by demand for cost-efficient and more sustainable solutions. At the same time, the importance of so-called "free-from" products is increasing, placing alternative material concepts to PVC more strongly into focus.

Polyolefin-based flooring is typically based on highly filled polypropylene compounds, whose properties can be specifically adjusted via the filler content. Production is carried out using suitable compounding processes, often involving twin-screw extruders, and enables both flexible and mineral-like product designs, including multilayer system structures with decorative, wear, and functional layers. Current development activities in the field of polyolefin-based flooring focus in particular on new formulations and process concepts.

Figure 1: Resilient Flooring

Challenges of PVC

PVC is an established material for resilient flooring and is widely used due to its technical and economic advantages. Its strengths include high durability, water resistance, and a high degree of design flexibility. In addition, PVC allows for easy installation and is generally cost-effective. In the event of fire, the material also exhibits favorable behavior, as it is not flame-promoting.

Despite these advantages, challenges are increasingly emerging that complicate the use of PVC. In particular, environmental and health aspects across the entire life cycle—from production and use to recycling—are gaining importance. Critical factors include certain raw materials and additives that are subject to regulatory restrictions. A key example is plasticizers such as phthalates, whose use is increasingly limited by European Union regulations.

Furthermore, PVC is partly associated with a negative public perception. Emissions of volatile organic compounds (VOCs) as well as the migration of additives over the service life contribute to this critical view. Against this background, there is a clear need for action: the use of PVC must be carefully evaluated and, where appropriate, supplemented or replaced by alternative materials or optimized material concepts that meet both technical requirements and environmental and regulatory standards.

PO-Based Flooring as an Alternative Material Solution

Polyolefin-based flooring offers a promising alternative to conventional PVC systems and can meet key functional requirements. These include durability, water resistance, design flexibility, as well as comparable processability and ease of installation.

In addition, polyolefin-based systems offer specific environmental and health advantages. They do not require plasticizers, which facilitate compliance with regulatory requirements, and they exhibit lower volatile organic compound emissions. Furthermore, the material is well recyclable, enabling reuse, for example, as a filler in new applications. Polyolefin-based flooring also meets the requirements for common environmental certifications and can be classified into appropriate fire protection categories through targeted material design, for example by using high filler contents. This results in a material solution that addresses both technical requirements and increasing environmental and regulatory demands.

Process Development of Polyolefin-Based Flooring

The production of polyolefin-based flooring involves several coordinated process steps that enable precise adjustment of material properties and final product quality. The fundamental substitution approach consists of replacing PVC in existing applications with polypropylene-based compounds without significantly altering the functional requirements of the final product. As part of a development project, a total of 15 different formulations were developed and evaluated, covering a thickness ranging from 2.5 mm to 5 mm.

At the beginning of the process, the raw materials—polymers, recyclates, additives, and fillers—are precisely metered and fed into the system via the feeding zone. This is followed by inline compounding in a twin-screw extruder, where the material is homogenized and endowed with defined functional properties. Filler contents of up to 80% can be achieved, with the compounds being specifically optimized in advance regarding processability and mechanical properties.

Figure 2: Calendering Machine with Laminating Unit

In the next step, the melt is shaped through a die, with a melt pump used to stabilize and ensure a consistent material flow. If required, co-extrusion can be integrated to enable the targeted production of multilayer structures. By varying the formulations, stiffness could be precisely adjusted, allowing both flexible systems such as Luxury Vinyl Tiles (LVT) and rigid systems such as Stone Polymer Composites (SPC) to be realized.

The subsequent calendering stage is used to precisely control material thickness and surface quality. A polishing calender is employed to calibrate both the decorative layer and the wear layer; optional backside lamination can also be applied. In parallel, a systematic evaluation of top layers was conducted with regard to suppliers, layer thickness, wear layer properties, and surface treatment.

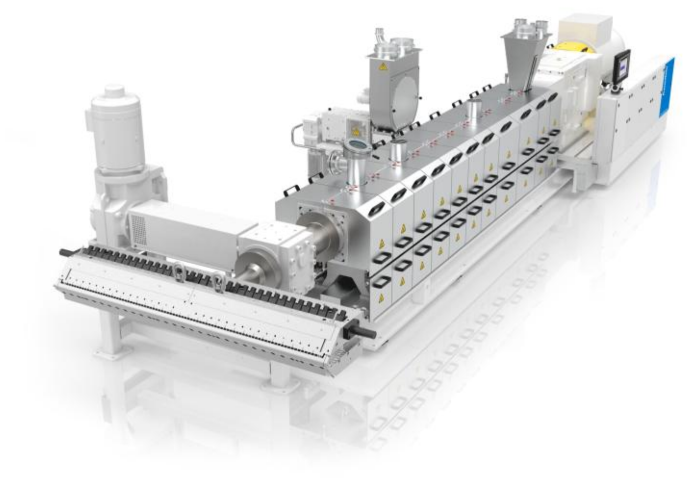

Figure 3: ZE BluePower

In the downstream section, the material is cooled, edge-trimmed, and cut to the required dimensions. Finally, processes such as digital printing, embossing, and coating enable the targeted design of optical and haptic properties, thereby defining the final functional and aesthetic characteristics of the product.

As part of the development project, boards with a width of 700 mm and varying stiffness, combined with different decorative films, were successfully produced. This confirms the fundamental technical feasibility and flexibility of the substitution approach.

Figure 4: Calender for Sheet Production

Processing and Application-Related Properties of Both Material Systems

From an economic and process engineering perspective, significant differences between the material systems can be observed. While PVC generally exhibits lower raw material costs per kilogram, this is associated with additional requirements in processing. Due to its material properties, increased corrosion protection of the processing equipment is required. In addition, PVC is typically processed as a dry blend, necessitating an upstream mixing stage using heating–cooling mixers.

Polypropylene, in contrast, can be directly fed from the silo into the process and processed accordingly. The higher process stability often enables increased throughput at comparable machine sizes, contributing to more efficient production.

Differences also arise in terms of performance and operational reliability. PVC processing is relatively sensitive to process interruptions. In such cases, material degradation may occur, leading to deposits that can negatively affect the equipment, requiring additional cleaning and purging procedures.

Polypropylene, on the other hand, demonstrates significantly more robust processing behavior. Typically, no separate purging materials are required, and the impact of material degradation on the equipment is lower. Overall, this results in a more stable and lower-maintenance production process.

Conclusion and Outlook

Polyolefin-based flooring provides the opportunity to actively shape technological developments in this segment and to position early in a dynamically growing market. Through optimized extruder configurations and targeted formulation development, high filler content can be achieved, enabling the production of high-performance, application-oriented flooring solutions.

Material properties can be adjusted over a wide range, allowing both flexible and rigid system designs to be realized. The integration of decorative and wear layers into the production process, combined with precise process control, ensures consistent surface quality and dimensional stability. Furthermore, tailored formulations and appropriately designed equipment configurations enable precise adaptation to specific requirements. Mechanical properties, filler systems, and application-specific specifications can be flexibly addressed.

Future developments will focus in particular on further advancement of material systems and process concepts. Key areas of interest include the integration of additional functional layers as well as new approaches to surface modification and coating technologies.