

Siegwerk's CIRKIT coatings: pioneering sustainable solutions with UPM and DG press for a circular future

Leading the paperization movement

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INTRODUCTION:

The global packaging industry stands at a transformative crossroads. Driven by escalating environmental concerns, shifting consumer expectations, and increasingly stringent regulations, the industry is being forced to rethink its reliance on plastic. Plastics, for decades, have been the material of choice for packaging due to their versatility, durability, and cost-effectiveness. However, their environmental impact—particularly the difficulty to recycle, their persistence in ecosystems and contribution to marine pollution—has prompted a global push toward more circular alternatives.

In recent years, governments, environmental organizations, and consumers have amplified their calls for change. Regulatory bodies across Europe, North America, and Asia have introduced legislation aimed at reducing plastic waste, banning single-use plastics, and mandating the use of recyclable or compostable packaging materials. As a result, brands and manufacturers are seeking new ways to meet these requirements while maintaining the functionality, safety, and aesthetic appeal of their packaging solutions.

Amid this shift, paper and board have emerged as viable alternatives to plastic for many applications, in a trend that has been named paperization. These fiber-based materials offer several intrinsic advantages: they are renewable, widely recyclable, and biodegradable, making them ideal candidates for circular economy models. Unlike plastic, fiber-based packaging can be more easily reintegrated into the production cycle, reducing waste and conserving natural resources.

However, while the environmental benefits of paper-based packaging are undeniable, its inherent limitations must be addressed to compete effectively with plastic. Uncoated paper, for instance, lacks the barrier properties required to protect products from moisture, grease, oxygen, and other external factors. Additionally, paper's natural porosity and mechanical properties can compromise its suitability for certain applications, such as food packaging, where safety, hygiene, and shelf life are critical.

This is where Siegwerk steps in. With a legacy of over 200 years in the inks and coatings industry, Siegwerk has consistently demonstrated a commitment to innovation, sustainability, and customer-centric solutions. Our CIRKIT range of coatings is the culmination of extensive research and development aimed at transforming paper and board into high-performance packaging materials capable of meeting the most demanding requirements.

The CIRKIT portfolio is designed to functionalize paper, enabling it to offer the necessary barrier protection, sealability, and printability to operate effectively as a packaging material, all while maintaining its recyclability and compatibility with existing recycling systems. By leveraging advanced water-based coating technologies, we are empowering brands and manufacturers to transition from plastic to paper.

In addition to our technological expertise, Siegwerk recognizes that collaboration is key to driving industry-wide change. Our collaboration with leading companies such as UPM and DG press exemplify our commitment to working across the packaging value chain to develop innovative, scalable, and sustainable solutions. Together, we are not only addressing the challenges of today's packaging landscape but also shaping the future of a circular economy where fiber-based materials play a central role.

Understanding the role of functional coatings in fiber-based packaging

Typical packaging papers and boards, while ideal for certain applications like cartons or dry goods packaging, struggle to meet the performance demands of other applications, particularly primary packaging for food, beverages, and personal care products. To expand the use of fiber-based packaging into these areas, the paper or board must be enhanced with functional coatings that address its limitations while preserving its environmental benefits. Let's examine some of the critical challenges that functional coatings are designed to solve:

1. Moisture

One of the most significant challenges with paper is its porosity and hydrophilic nature, which makes it highly absorbent and vulnerable to moisture ingress as a packaging material. When exposed to humid environments or direct contact with liquids, untreated paper can weaken, warp, and eventually lose its structural integrity.

In packaging applications, particularly for food and beverages, maintaining moisture resistance is critical to protecting the contents, ensuring shelf life, and preserving product quality. Products like frozen foods, dairy, and beverages require packaging that can withstand cold storage or refrigeration without compromising performance.

Siegwerk's CIRKIT coatings provide a robust solution to this challenge. By applying a water-based barrier coating, we can significantly reduce the porosity of paper, creating a hydrophobic layer that repels moisture and protects the substrate from environmental conditions. This enhancement allows paper-based packaging to maintain its strength, rigidity, and appearance even in moisture-rich environments.

2. Fat, Oil & Grease

Unlike glass, aluminum, and some laminated structures, which provide effective barriers against fats, grease, and oils, paper lacks the properties needed to block these substances. This limitation makes uncoated paper unsuitable for packaging products that are sensitive to grease leakage, such as snacks, baked goods, and ready-to-eat meals. Grease, fat and oil can seep through uncoated paper, causing staining, compromising the package's appearance, and even weakening its structural integrity.

CIRKIT coatings are engineered to address these vulnerabilities by providing an effective barrier against fats, grease, and oils. The coatings form a continuous, defect-free layer over the paper surface, preventing the migration of these substances and maintaining the integrity of the packaging.

3. Sealability

Secure seals are a fundamental requirement in many packaging applications, ensuring that the contents remain contained inside and protected from external contaminants, maintaining freshness, and even providing tamper evidence. However, achieving reliable seals with paper-based materials can be challenging, particularly in high-speed production environments where consistency and precision are critical. Therefore, paper requires specialized coatings to enable effective sealing.

Siegwerk's CIRKIT range includes coatings specifically designed to enhance the sealability of paper-based packaging. These coatings enable wide operational sealing windows on packing lines, allowing for the creation of paper-based packs without compromising on efficiency.

4. Additional Functional Enhancements

In addition to moisture resistance, barrier protection, and sealability, functional coatings can also impart other desirable properties to paper-based packaging, including:

- **Heat Resistance:** Ensuring the packaging can withstand high temperatures during processing, storage, or consumer use (e.g., microwave or oven-safe packaging).
- **Printability:** Providing a smooth, uniform surface that enhances print quality, allowing for high-resolution graphics, brand messaging, and product information.
- **Flexibility and Foldability:** Maintaining the mechanical properties of the paper, ensuring it can be folded, creased, or shaped without cracking or delaminating the coating.
- **Anti-Static and Anti-Stick Properties:** Reducing static buildup and preventing products from sticking to the packaging surface, which is particularly important for confectionery and bakery products.

Siegwerk collaborates closely with industry partners, including paper mills, converters, and brand owners, to optimize the functionalization process. By conducting extensive testing and validation, we ensure that our coatings not only meet the technical requirements of each application but also align with the environmental goals of our customers and the broader packaging industry.

Through continuous innovation and a collaborative approach, Siegwerk is enabling the next generation of paper-based packaging solutions.

Coating applications across the value chain: online, offline, and in-line varnishing

As discussed, in the production of paper-based packaging, coatings play a critical role in enhancing the substrate's functional properties, such as barrier protection, sealability, and printability. The point at which these coatings are applied within the value chain significantly impacts their performance, production efficiency, and overall cost-effectiveness.

Coatings can be applied online (during paper production), offline (after the paper has been produced), or as an in-line varnish during the printing process. Each application method has its strengths, weaknesses, and ideal use cases. Selecting the appropriate method depends on the desired properties, production constraints, and end-use requirements.

1. Online Coating

Online coating refers to the application of functional coatings directly on paper or board during its production on the paper/board machine. This process often uses specialized equipment for high-speed applications.

Strengths:

- **High-Speed Application:** Online coating is performed at the same speed as the paper machine, allowing for rapid production and high throughput.
- **Cost-Effective:** By integrating coating into the paper production process, manufacturers can reduce the need for additional processing steps, minimizing handling and logistics costs.
- **Drying capacity:** Modern online coating systems often utilize contactless drying methods, such as infrared (IR) or hot air, which help achieve consistent drying without damaging the substrate.

Weaknesses:

- **Limited Flexibility:** Online coating processes are less adaptable to small production runs or customized formulations, making them more suitable for high-volume, standardized products.
- **High Setup Costs:** The integration of coating systems into the paper machine requires significant capital investment and technical expertise.
- **Contact Drying Constraints:** Coatings applied online by Film or Size Press which are then in contact with drying cylinders must be optimized to dry quickly without tackiness, which can limit the types of formulations that can be used.

Best Fit:

Online coating is ideal for large-scale production of packaging grades requiring low-to-mid barrier performance, such as food wraps and industrial packaging.

2. Offline Coating

Offline coating involves applying functional coatings to the paper or board after it has been produced, using separate coating machines such as air knife, rod, or curtain coaters. This process can be conducted anywhere in the value chain, including at a Paper/Board Mill converter facility, or a specialized coating plant.

Strengths:

- **Greater Flexibility:** Offline coating allows for customization of coating formulations, layer thickness, and application techniques, making it suitable for a wide range of products and substrates.
- **Enhanced Coating Quality:** Offline processes often provide more precise control over coat weight, coverage, and drying, resulting in a homogeneous, defect-free surface.
- **Multiple Coating Layers:** Offline systems can often apply multiple layers of coatings, including primers, functional layers, and topcoats, to achieve complex performance requirements.
- **Post-Printing Coating:** Offline coating can be applied after printing, enabling additional functionalities or protective layers without interfering with the print process.

Weaknesses:

- **Additional Processing Step:** Offline coating adds an extra step to the production process, increasing handling, logistics, and overall production time.
- **Higher Production Costs:** Due to the additional equipment, labor, and energy required, offline coating can be more expensive than online processes.
- **Best Fit:** Offline coating is ideal for specialty applications that require high customization and/or high barrier, such as more sensitive food packaging, or products with specific orgaleptic requirements.

3. In-Line Varnishing

In-line varnishing refers to the application of a thin layer of coating (or “varnish”) directly on the substrate during the printing process, typically using flexographic, rotogravure, or offset printing presses equipped with varnishing units.

Strengths:

- **Seamless Integration:** In-line varnishing integrates coating into the printing process, reducing production time and eliminating the need for separate coating equipment.
- **Cost Efficiency:** By combining printing and coating in a single pass, in-line varnishing reduces handling and logistics costs, making it a cost-effective option for many applications.
- **Customizable Performance:** In-line varnishing allows for selective coating application, enabling spot varnishing, patterns, or areas with different finishes (e.g., gloss vs. matte).

Weaknesses:

- **Lower Coatweight:** In-line varnishing typically applies a lower coatweight compared to dedicated coating methods applied online or offline.
- **Limited Drying:** Printing presses are often limited in the amount of drying capacity they have, which may restrict their use for some formulations and/or for applications requiring higher coatweights.
- **Best Fit:** In-line varnishing is ideal for some lower barrier packaging applications where smaller, more flexible batch sizes are needed. Additionally, using in-line varnishing to add top-up functionality to precoated papers is a great way to tackle some of the most demanding packaging applications; whether enhancing barrier performance, adding heatseal, or even managing physical properties, such as CoF or heat resistance.

By understanding the strengths and limitations of each coating application method, packaging manufacturers can make informed decisions on how to best functionalize their paper-based packaging for specific end-use applications, and brand owners can understand the partners needed to enable a successful paperization transition. Siegwerk’s CIRKIT range includes products compatible with all these methods, providing flexibility and performance across the entire value chain.

Summary of coating application methods

Method	Strengths	Weaknesses	Best Fit
Online Coating	High speed, cost-effective, optimized barrier performance	Limited flexibility, high setup costs	High-volume packaging with barrier needs
Offline Coating	Customizable, precise control, multiple layers	Additional processing, higher costs	Specialty and luxury packaging
In-Line Varnishing	Seamless integration, cost-effective, print protection	Limited barrier performance, lower coat weight	Consumer goods and promotional packaging

Collaboration as a catalyst for innovation

Innovation does not happen in isolation. It requires a synergistic ecosystem where value chain partners (e.g. converters, paper suppliers, and chemical technology providers) work together to solve complex challenges. Siegwirk recognizes that the future of sustainable packaging depends on collaboration across the entire value chain. By partnering with industry leaders like UPM and DG press, Siegwirk is able to optimize its CIRKIT coatings for specific substrates, printing technologies, and end-use applications. These partnerships enable Siegwirk to deliver fiber-based solutions that meet the functional, economic, and environmental requirements of modern packaging, driving the industry closer to a circular economy.

Case Study: Razor Blade Pouches

UPM: Enhancing Substrate Performance

UPM Specialty Papers, a global supplier of high-performance barrier and barrier base papers, plays a critical role in the success of Siegwirk's CIRKIT coatings. As the substrate serves as the foundation for any coating application, the properties of the paper—such as smoothness, density, porosity, and mechanical strength—directly impact the performance of the coating.

The partnership between Siegwirk and UPM Specialty Papers focuses on maximizing barrier performance, print quality, and recyclability by combining CIRKIT coatings with UPM's barrier base papers, which are designed for coating.

The Challenge

Develop a recyclable, heat-sealable paper pouch for razor blades that could replace traditional multi-layer plastic laminates. The packaging needed to provide robust barrier protection, heat-seal strength, and durability to safely contain and protect the sharp blades, while maintaining full recyclability.

Solution:

The solution involved using UPM's Solide™ Lucent and UPM Prego™ substrates, which offer excellent surface smoothness and structural integrity. These substrates were coated with Siegwirk's high-performance CIRKIT BAR SEAL PR 1643 and CIRKIT BAR SEAL PR 1684 barrier coatings, designed for heat-sealing and moisture resistance.

Results:

- **Heatseal Strength:** Achieved seal strength of up to 3.2 N/15mm, ensuring secure and tamper-evident seals.
- **Barrier Protection:** Provided robust resistance against moisture and external contaminants, critical for maintaining the integrity of razor blade packaging.
- **Full Recyclability:** The paper-based pouch met recyclability standards, aligning with circular economy principles.

Outcome:

This project demonstrated that fiber-based materials could meet the requirements of razor blade packaging, providing a viable and sustainable alternative to plastic. The collaboration with UPM underscored the importance of optimizing substrate performance to fully leverage the capabilities of CIRKIT coatings.



Case Study: Peppermint Pouches for Drupa 2024

DG press: Scaling Coatings for High-Speed Printing

While substrate optimization is critical, the ability to scale coatings for industrial production is equally important. This is where Siegwirk's partnership with DG press comes into play. DG press specializes in high-speed hybrid web offset presses in which flexo and gravure printing units are integrated, enabling the efficient application of Siegwirk's CIRKIT coatings at an industrial scale. This collaboration ensures that Siegwirk's solutions are not only technically robust, but also commercially viable for large-scale production.





Challenge:

Create recyclable, in-line printed, and coated peppermint pouches for Drupa 2024, the world's largest print media exhibition. The pouches needed to demonstrate extended shelf life, grease resistance, and high print quality, all while being scalable for mass production.

Solution:

DG press applied Siegwirk's CIRKIT BAR SEAL PR 1684 with its hybrid web offset press, utilizing integrated up- and down-stream gravure and flexographic printing units. The coating was applied to UPM's Solide™ Lucent substrate, leveraging the substrate's smooth surface and mechanical stability for optimal coating adhesion and performance.

Results:

- **Water Vapor Transmission Rate (WVTR):** Achieved a good WVTR, extending the shelf life of the peppermint products by minimizing moisture ingress.
- **Oil and Grease Resistance:** Provided superior resistance to oil and grease, ensuring the pouch maintained its structural integrity and visual appeal even with oily contents.
- **Scalability:** Demonstrated seamless scalability, enabling the production of high-quality, recyclable paper pouches at industrial speeds of up to 160 m/min on DG press's DG-AUXO 900 combination gravure and flexo press.
- **Sealability:** Excellent sealing window for easy to process on a packaging line, and good bond strength to ensure pack integrity.
- **Food contact safe coating:** Of course, food safety cannot be compromised and all materials used are suitable for use in food contact packaging materials.

Outcome:

The project showcased the feasibility of producing high-barrier, recyclable paper pouches at a commercial scale, positioning Siegwirk and DG press as leaders in sustainable packaging innovation. The success of the peppermint pouches highlighted the critical role of high-speed printing technologies in scaling fiber-based solutions for mass-market applications.

Leading the charge toward a sustainable future

As the demand for sustainable packaging intensifies, Siegwirk is poised to help lead the industry in the transition to fiber-based solutions. Through continued innovation in our CIRKIT coatings and strategic collaborations with key partners like UPM and DG press, we are enhancing the functionality and scalability of paper-based packaging while supporting the shift towards a circular economy.

The future of packaging lies in finding a balance between performance, sustainability, and scalability. Siegwirk's commitment to developing solutions that are not only functional, but also environmentally responsible positions us as a key enabler in this transition. As we move forward, our focus will remain on creating coatings that improve barrier properties, promote recyclability, and enable high-speed production—all while fostering partnerships that bring sustainable solutions to market.

Siegwerk is dedicated to shaping the future of packaging, ensuring that fiber-based materials not only replace plastic, but also contribute to a more sustainable, circular economy for generations to come.

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