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CoolFeel: Footwear Lining Design Providing a Cooling Sensation through Dual-Component Finishing

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Abstract

The CoolFeel project introduces an innovative footwear lining design that provides a tangible cooling sensation, enhancing user comfort in hot weather or during intense physical activity. This design incorporates the Cool In dual-component finishing system developed by Proneem, applied via spray coating onto the surface of the shoe lining. The treatment is mechanically activated and engineered to generate a localized temperature-reducing effect under humid conditions.
The project aims to integrate this technology into footwear manufacturing processes while ensuring material compatibility, production efficiency, and consumer-level performance. Laboratory evaluations conducted before and after repeated washing cycles revealed that the treated lining maintains similar absorption speed compared to untreated samples, yet demonstrates superior moisture diffusion rates (up to 1.37 times faster when unwashed) and

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infrared-measurable surface temperature reduction of up to 1.4°C. Even after ten washing cycles, the system retained moderate performance with a 0.5°C temperature drop and over 1.07x faster diffusion rate. CoolFeel represents a sustainable and consumer-driven innovation that addresses thermophysiological discomfort in footwear. It offers a viable solution for brands seeking to differentiate through functional design and enhanced user experience, particularly in warm climates and performance-driven market segments.

Keywords: Cooling Footwear, Functional Textile, Temperature Regulation, Dual-Component Finishing, Consumer Comfort

1. Introduction

In recent years, growing consumer demand for comfort-focused footwear has driven innovation in functional materials that enhance thermal regulation [1]. The development of textiles and linings that provide dynamic temperature regulation has gained increasing attention in the field of personal thermal management [2], [3]. Elevated foot temperatures caused by environmental heat or physical exertion contribute to discomfort, fatigue, and perspiration accumulation. These conditions negatively affect user experience, particularly in summer climates or during high-performance activities [1]. To address this issue, innovations that introduce cooling effects into footwear design have emerged as a new frontier for both functional textile development and user-centric product engineering.

The CoolFeel project aims to provide a sustainable and innovative solution by applying a dual-component functional finishing system — Cool In by Proneem — to the inner lining and sockliner surface lining of footwear. This finishing, when applied by spraying, creates a homogeneously distributed treatment that reacts to mechanical stimuli and moisture by delivering a noticeable cooling sensation. The project evaluates the integration of this finishing into mass production processes and assesses its long-term durability, performance, and potential to open new product segments in the footwear market, leveraging advancements in smart textile technologies for thermal management [4].

2. Materials and Methods

2.1. Treated Material and Application Technique

The base material selected for this study was a standard black and white polyester-based lining fabric commonly used in athletic shoes. The Cool In finishing was applied using a

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controlled spray system under factory conditions to ensure uniform distribution across the surface. The finishing combines two active components designed to react to mechanical stimulation (pressure, flexion) and humidity. This approach aligns with established methods of PCM integration into textiles, such as microencapsulation and coating techniques, which have been extensively reviewed in the literature [5].

2.2. Laboratory Test Conditions

All samples were tested at Proneem Laboratories (Marseille, France) in accordance with standard and internal testing procedures. The following metrics were evaluated:

- Water absorption speed – AATCC 79 standard
- Moisture diffusion speed – internal diffusion measurement method (mm/s)
- Temperature reduction – infrared imaging under moisture presence

2.3. Wash Durability Protocol

To assess durability, samples underwent testing at three conditions:

- T0 – untreated (control) and Cool In-treated fabric
- T5 – Cool In-treated fabric after 5 washing cycles
- T10 – Cool In-treated fabric after 10 washing cycles

All washings followed ISO 6330 domestic laundering procedure with standard detergent and ambient drying.

3.1. Moisture Management Performance

All treated and untreated samples showed "instantaneous" absorption (<16 seconds), indicating that the application of the Cool In finish does not compromise the fabric's water uptake ability. While previous literature has established that absorbency rates in textiles are primarily influenced by fiber type, yarn construction, and fabric structure [6], the current findings demonstrate that these inherent characteristics remain functionally intact even after the dual-component finishing is applied.

Diffusion Speed: The Cool In-treated fabric displayed enhanced moisture diffusion:

Table 1: Diffusion speed of moisture after washing cycles

Sample Condition	Diffusion Speed (mm/s)	Relative Increase
Untreated (Control)	3,66	-
Treated (0 Wash)	5,02	+37%

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Treated (5 Washes)	4,50	+23%
Treated (10 Washes)	3,92	+7%

3.2. Infrared Thermal Imaging

The IR tests confirmed that treated samples reduced surface temperature under moist conditions:

Table 2: Washing impact on temperature reduction

Sample Condition	**Temperature Reduction (°C)**
Treated (0 Wash)	1.4°C
Treated (5 Washes)	0.6°C
Treated (10 Washes)	0.5°C

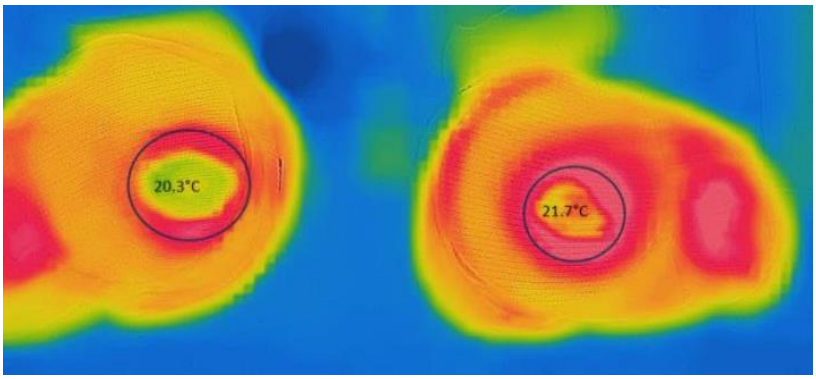

Figure 2: Treated sample on the left, untreated sample on the right

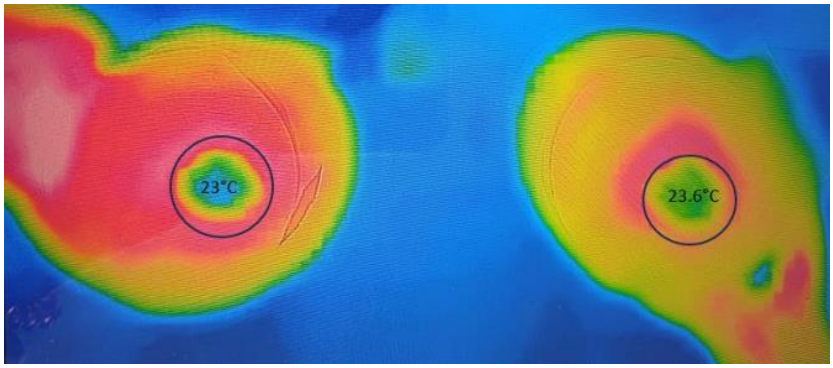

Figure 3: Treated sample after 5 washes on the left, untreated sample on the right

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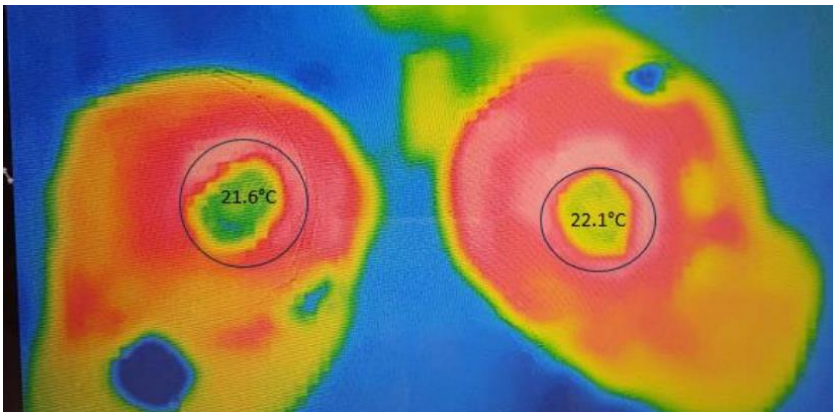

Figure 2: Treated sample after 10 washes on the left, untreated sample on the right.

These results demonstrate that Cool In treatment introduces a measurable cooling effect, which remains partially preserved even after multiple washing cycles.

4. Discussion and Conclusion

The CoolFeel project confirms the viability of integrating dual-component functional finishes into footwear linings to enhance thermal comfort. While absorption capacity remains unchanged, moisture diffusion improved significantly, facilitating quicker drying and reduced foot dampness. These findings are consistent with previous research demonstrating that specific fabric properties, such as thermal resistance and water vapor permeability, play crucial roles in enhancing the thermal comfort of footwear linings [7]. The cooling effect measured under IR conditions offers a direct benefit to users, potentially reducing thermal discomfort in hot environments or during extended wear.

Durability analysis indicated performance decay over washing cycles, yet the treatment retained part of its functional impact even after 10 washes. This makes CoolFeel suitable for seasonal or performance-focused footwear where short-to-medium term functional enhancement is prioritized, aligning with the broader movement toward intelligent textiles that regulate thermal comfort dynamically [4].

Overall, the CoolFeel system contributes to the development of functionally differentiated footwear products, positioning itself as an innovation that aligns with consumer comfort trends, production efficiency, and sustainable material use.

5. Acknowledge

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