

## Wash Life Durability Analysis of a Printed Cooling Technology on Cotton Textiles

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Active cooling technology has been a game-changer with regards to textile finishes and physiological benefit provided to end users. Since being developed by NASA in the late 1980s, phase change materials (PCM) have been successfully implemented in specialized protective clothing (NASA, 2009) and are now commonly incorporated in consumer apparel with a wide range of end uses (McFarlin, Henning, Venable, Williams, & Best Sampson, 2016). In order to absorb heat and cool the skin, PCMs are often encapsulated in a polymer shell and applied as a finish to the surface of the fabric. This ease of application has increased the possible uses of this technology in the apparel and textile market.

In order to understand the durability and performance of a PCM finish on multiple cotton fabrications and to provide information necessary to the industry on the use of cotton versus other fiber types, a wash life analysis study was performed. Two 100% cotton textiles with a printed phase change material finish were evaluated – a jersey single knit fabric, likely for apparel applications, and a woven twill fabric, potentially for upholstery applications (Fig. 1). The PCM finish was applied to the back side of the fabrics. Both of the textiles incorporate Wicking Windows™ Technology, which intends to transfer moisture away from the skin. The specific edition of the proprietary technology assessed within this study utilized PCM finishing to create an aesthetic print of repellent areas and “windows”, or areas with no print (Cotton Incorporated, n.d.). These “window” designs can be seen in Figure 1 as a spiraling design (left) and a floral print (right).

The project design was modeled after a previous study that evaluated polyester t-shirts with a printed PCM finish (McQuerry, 2018). Six 15''x15'' specimens from the gray 100% cotton jersey knit fabric and six 15''x15'' specimens from the tan 100% cotton woven twill fabric were tested. Ballast fabric was added to form a standard four-pound laundry load and together, the 12 specimens and ballast fabric were washed 25 times to replicate a typical consumer wash life. Each consumer laundering wash cycle was set on “Normal” and filled with 38g of liquid detergent and cold water. Each load dried for 40 minutes on low heat. The specimens were evaluated for dimensional stability, colorfastness, crocking,

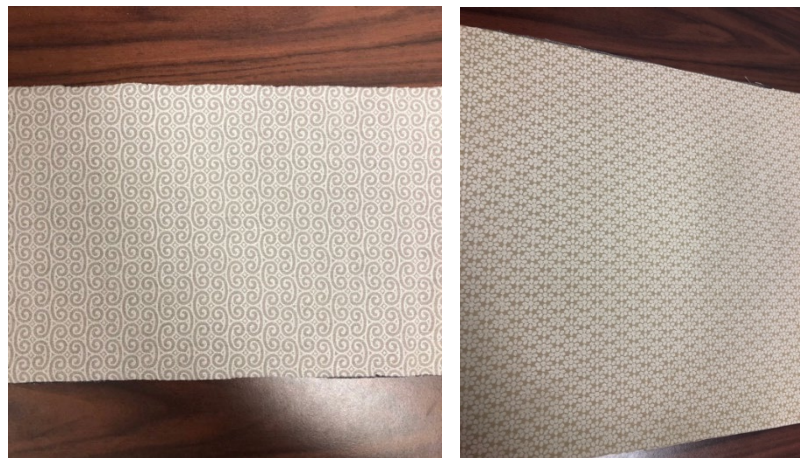


Figure 1. The back sides of the gray knit fabric (left) and the tan woven fabric (right). The PCM finish was applied to the back of these fabrics in aesthetically pleasing designs.

abrasion resistance, soil release, and smoothness retention according to AATCC and ASTM standard test methods. Testing was conducted new and after 1, 5, 10, 20, and 25 consumer laundry (CL) cycles. Microscopic images were also taken in order to gain a better understanding of the application of the finish (Fig. 2).

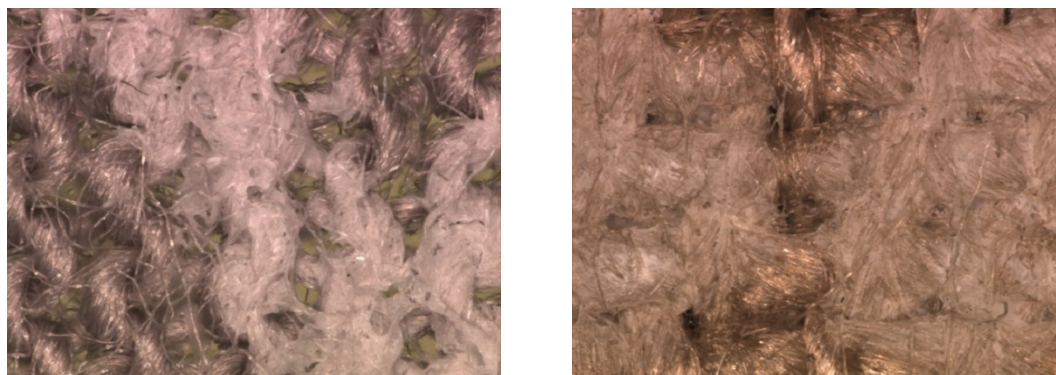
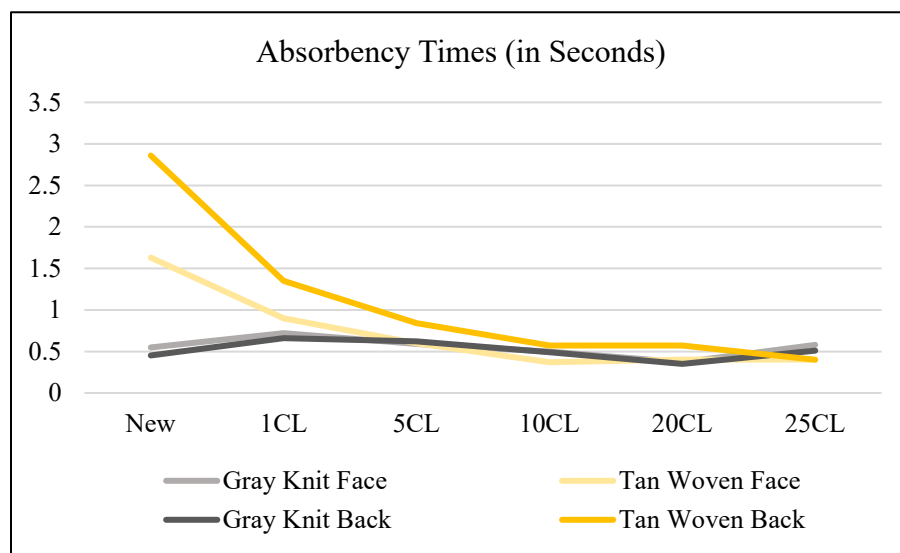


Figure 2. Microscopic images of the PCM finish on the surface of the gray cotton knit fabric (left) and the tan cotton woven fabric (right).

When assessing colorfastness, dimensional stability, abrasion and pilling, soil release, smoothness, and crocking, results were consistent between the knit and woven cotton fabrics. Absorbency results,



however, differed significantly before and after washing. As shown in Figure 3, the absorbency of the face (1.63 sec) and back (2.86 sec) sides of the woven cotton Wicking Windows™ Technology fabric differed significantly ( $p < 0.05$ ) at new, prior to washing. After washing, the absorbency of the face and back sides of the woven cotton fabric were significantly different until

25 consumer launderings occurred. As the PCM finish was applied to the back side of the fabric, these results demonstrate the diminishment of the finish over multiple wash cycles. No significant differences in absorbency were found for the knit cotton fabric suggesting the PCM finish was more stable when applied to this fabric. While evaluating absorbency, the researchers were able to observe the absorption pattern. When water is applied to the back of the fabric, it quickly finds a “window” and moves through the fabric, as suggested by the Wicking Windows™ Technology.

Overall results demonstrate the Wicking Windows™ Technology finish is durable in terms of appearance retention regardless of the cotton fabrication substrate (woven or knit). The moisture management performance, however, does differ significantly between the knit and woven fabric the finish was applied to in this study. Absorbency is a key comfort parameter for which this wicking technology was created to manage and improve. Further research is necessary to assess additional moisture management properties of the technology both on the fabric and human wear levels.

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