Thermochromic Exothermic Cycling Wear (T.E.C.)

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Contextual Review and Concept

The worldwide movement of social distancing due to COVID-19, minimized group sports activities and locked down the indoor sports facilities (Wong et al., 2020). Therefore, the two keywords can explain the trend of sports in post COVID-19; individual and outdoor. Cycling is one of the most popular sports suitable for post COVID-19 trend (Choi & Bum, 2020). However, the problem of cycling as a daily activity is the outside temperature. According to previous studies, there is a significant relationship between cycling frequency in winter and outside temperature, and the quantity of cycling decreases sharply at temperatures below 5°C (Amiri & Sadeghpour, 2015; Jin & Lee, 2013). Therefore, cycling wear with heating systems is required in order to encourage cycling in cold weather by maintaining body temperature.

Thermochromic pigments are special pigments that become colorless in response to rising temperatures (Kulčar et al., 2010; Potuck et al., 2016). Thermochromic pigments have been used in various fields such as sportswear for the detection of physical exhaustion or color-changing military uniforms in response to climate changes (Karpagam et al., 2017; Zhang et al., 2019; Lee et al., 2020). Winter clothes with heating systems face sub-zero temperatures at the moment of going outside, but the temperature rises in a wide range due to the operation of the heating system. Thus, the application of thermochromic technology in winter cycling wear is thought to be the optimized usage for noticeable color changes.

For these reasons, we developed functional cycling wear with two core functions; thermochromic and heating, and named it Thermochromic Exothermic Cycling wear (T.E.C.).

Process, Technique, and Execution

T.E.C. project was guided by the Apparel Design (AD) Framework (Lamb & Kallal, 1992), from *problem identification* through *prototype development*.

In *design refinement* stage, the design of T.E.C. were completed based on survey results, literature review, and designers' intention. The heating systems were applied on the body parts that the cyclists feel particularly cold as shown in Figure 1. Fluorescent orange that was ranked highest in perceived hazard (Zielinska et al., 2017) was chosen as the main color to enhance night visibility. In addition, thermochromic printings, imposed on the orange parts, were inspired by exercise-induced activation of blood flow.

Prototype development stage was largely divided into two components; pattern development and integration of 3-layer heating system. CLO 3D was used to develop initial 3D patterns based on the default size of avatar MV2_Thomas. (Height: 187cm, chest: 96.5, and waist: 82.5), which details were finetuned in YUKA CAD.

The 3-layer heating system consists of main fabric (bottom layer), heating film (mid layer), and thermochromic ink printed fabric (top layer). For the top layer, thermochromic pigments were prepared to change color at 35℃ or above and printed on the fluorescent orange fabric with silicon printing method to prevent cracks which could often occur in stretchable fabrics. The heating film was attached to a power switch and a lightweight battery through electric wires. When the wearer turns on the heating film by pressing the switch button, the temperature of the system rises and thermochromic prints (black prints on top layer) disappear (Figure 2). T.E.C. consists of black and white fabric (78% nylon, 22% spandex) and fluorescent orange fabric (85% nylon, 15% spandex). The jersey (top piece) was sewn with 304 zigzag lockstitch and the bib tights (bottom piece) were sewn with 607 4 needle six flatlock stitch.

Design Contribution and Innovation

Developed in this design project, T.E.C. is functional clothing that enables wearers to actively cope with the outdoor temperature and safety problems through two core technologies, thermochromic and electric heating. As mentioned by one of the survey participants "the risk of accidents in winter is relatively high compared to other seasons because of the lack of body responsiveness caused by the cold." Thus, it is expected that the heating function of T.E.C. will not only enable cyclists to overcome low temperatures but also prevent accidents by maintaining body responsiveness. Moreover, the use of fluorescent orange color and reflective tapes enhanced the visibility of the cyclists from car drivers. In conclusion, T.E.C. is a new concept of sportswear that can encourage individual and outdoor sports activities in post COVID-19. T.E.C. is the result of optimal convergence between various technologies and clothing, and has expanded the possibility of developing a new type of functional clothing with technologies suitable for various situations.

Figure 1 Flat sketch

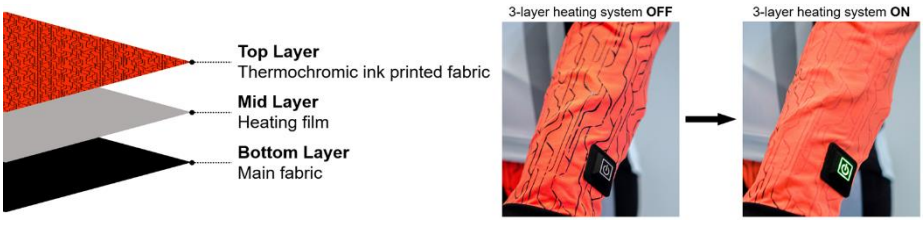

Figure 2 3-layer heating system

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