

Light as a Material of E-Textile Composites [†]

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Abstract: This paper presents initial material studies of the project Personal Wearable Lightspace. The aim of the described work is to explore how light can be considered as an inherent property of a composite material, consisting of textiles, electronics, and light. The properties of interactive materials are diverse, combining expression in inactive states with changing appearance during active phases. A series of small design explorations into e-textile composites has been done, with the aim to understand better the characteristics we achieve by varying the construction of their components. We present a series of material studies and designs for composites. In the discussion, characteristics and material choices are compared. Finally, the conclusion gives an overview on design parameters for e-textile composites regarding the function and aesthetics, including the textileness of its interaction design or the involvement of bodily data to create a somaesthetic experience.

Keywords: e-textile composites; soft interaction; light wearable

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1. Introduction

The project aims to design material composites consisting of textiles, electronics, and light to identify the properties of designing wearable light spaces on the body. We briefly outline two preceding projects. “Betelight” (2018, see Figure 1) explored the impact of a wearable light space on the body with focus on technical and sustainable aspects [1]. “Explorer’s Lightspace in Mojave Desert” (2019, see Figure 2) studied the potential of designing a nonphysical defined space with a wearable light source [2]. Both projects incorporated soft technology with mechanical control components, such as fabric switches activated by physical interaction. Light was directed by moving the body.



Figure 1. BETAlight worn in public environment.



Figure 2. Explorer’s Lightspace in Mojave Desert. The wearable light creates a lit-up space around the wearer.

In the next step, we explored the material properties of light devices in a series of mock-ups, which allow a physical change in the light source. The first mock-up is constructed from a coated nonwoven fabric, transformed through a smocked honeycomb pattern (Figure 3). LEDs are integrated inside the pleats. By moving the composite the rhombi of the structure open and close, comparable to effects created by technical light grids [3]. The second mock-up (Figure 4) is a sleeve with LEDs attached to the cuff. Through pattern construction and ruching, the position and angle of the lights are changed. Mock-up 3 (Figure 5) is an illuminated thermoplastic polyurethane (TPU bubble) filled with a water-based washing gel, which is attached directly at the skin.

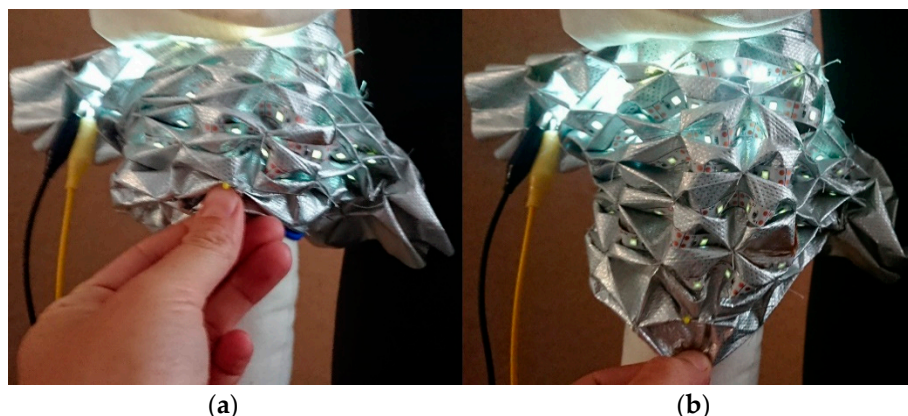


Figure 3. Mock-up 1 with light-grid function closed (a) and opened (b).

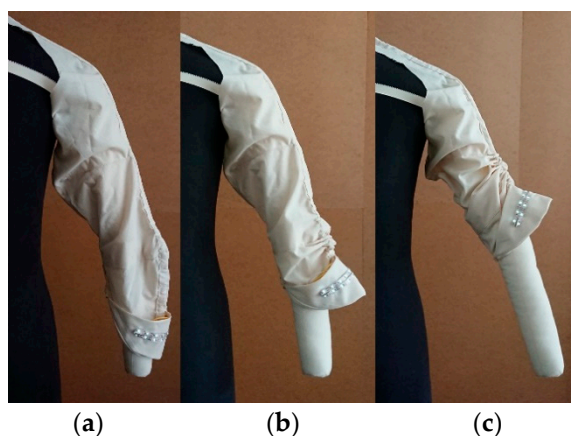


Figure 4. Mock-up 2 pulled up into three different states, shining down (a), sideways (b) and upwards (c).

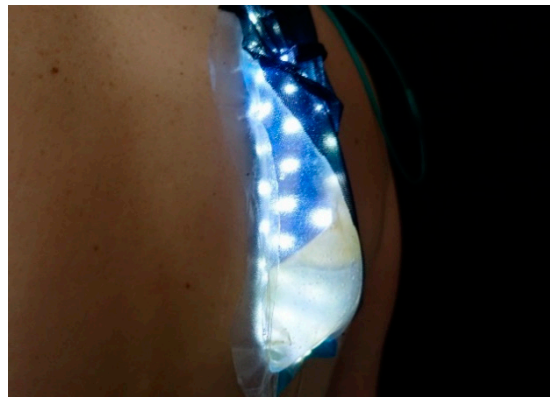


Figure 5. Mock-up 3: A soft light bubble extends the body.

2. Methodology and Design

As a starting point of the study, fields in the design of the wearable light space were identified: (1) body posture and movement, (2) shape of the lighting body, (3) incorporation of the light source. In the next step, possible design directions were developed with the aim to achieve a wide range of aesthetic prototypes.

In the first mock-up, we applied the effects of light grids commonly used in film lighting. These were translated into a smocked honeycomb pattern, where the structure changed the emission of light according to the aperture of the structure elements. When attached to the body, the pattern opened horizontally, operated through the physical movement.

The second mock-up explored the interaction and change of the light space by the shape of a sleeve and its interaction through ruching it. The sleeve had a Z-Shape (Figure 4a), where the light panel was attached to the cuff. Pulling the cord in the sleeve, the light panel moved upwards along the Z-Shape, changing its direction to upwards (Figure 4c). The cuff could also be rolled up, which resulted in an indirect light effect.

The third mock-up aimed to incorporate light even closer to the body. The shell material was a transparent TPU foil filled with gel. Underneath was a composite of physio tape with a flexible LED-panel to be attached directly to the body.

3. Findings

Mock-up 1 showed the most different states on joints of the body. It was tested on the elbow, which made simple bowing of the arm control the light intensity. Different diffusions were applied on top of the smocking structure, to achieve an enclosed design.

Mock-up 2 added pattern cutting to the material composite. The textile material reflected the light in the folds, the ruffled structure became part of the light design. The textileness [4] of the material was used for the interaction, the ability to control position and direction of the light.

In Mock-up 3, the materiality resulted in a soft texture. It was attached directly to the skin with help of medical adhesive tape. The device was not only worn on the body, but the light became a part of the body. The TPU foil did not lead to a textile texture but featured a flexible interface. The application via the adhesive tape directly to the skin opened a new layer of body relationship, incorporation, and embodiment.

Even simple manual movements of the samples resulted in a wide range of material expressions. The materiality of each mock-up was essential for the design and performance, comfort for, and interaction with the wearer. Mock-up 1 for example was tightly shaped to follow the movements of the elbow, which might restrict the wearer. Mock-up 2 could relate to a fashionable sleeve with a playful additional function. The light change was controlled by pulling the string. It left a moment of uncontrolled “shaping” of the output as the sleeve was soft and flexible. For the conceptual part of the project, the idea

of light being part of the skin rather than implemented in the clothing, adds another layer of bodily relationship to the composites.

4. Conclusions

For the design with e-textile composites made of tangible and intangible material, the following parameters should be considered:

- the soft materiality;
- the technical approach in the fabric manipulation;
- the relationship between physical interaction and programmed input and output;
- the bodily relationship with the implemented technology.

These relate mutually to one another: the light on the textile material shapes the wearer's appearance (mock-up 2). In mock-up 1, the movement of the textile structure shapes the light intensity. The proximity of the light wearable to the body in mock-up 3 applies the light as part of the body, where the clothing becomes a light dimmer. In the three mock-ups, physical interaction with the materials allows the wearer to actively take part in the interaction by using the material characteristics.

The composite samples were small, and in the next steps full-body interaction will be developed. Material selection for textile substrates will be done. Another part of the research will be to investigate how bodily data and sensors can be integrated into the group of material components.

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