

Origami Inspired Innovations for Sag Reduction, Shape Conformance, and Wicking Technologies

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Abstract

Although there have been many improvements, both medically and mechanically, for incontinence products, the adult diaper still remains problematic in protecting human dignity. Adult diapers are wearable, absorbent garments that are designed to help individuals with incontinence issues to live more normal lives. While these products allow the wearer to leave his or her home, they do not provide freedom from worries of leakage, noise from movement, undesirable odors, and sag of the garment.

These concerns originate in the challenge of accommodating a significant number of different body shapes, sizes, and mobility; adapting sheet material to conform to curved surfaces; and maximizing absorption capabilities. Improvements made in the areas of shape conformance, sag reduction, and wicking technologies will decrease concerns of leaking and sag.

Origami has the potential to play a vital role in each area of needed improvement. Shape conformance can be improved by utilizing the deployability of origami. Designs are developed from origami patterns that allow additional fabric to deploy for larger sizes, but also perform the necessary functions in stowed or intermediate stages of deployment for smaller sizes. The deployment patterns will be able to accommodate slender figures, rounder figures, moving figures, and sedentary figures. The specific kind of fit can be controlled by the pattern used, as shown in Figure 1a, where four patterns were tested to show that horizontal stiffness may be controlled at various points by the pattern selected.

Origami-inspired patterns, incorporated into diaper designs can decrease sag by providing controlled and selective stiffening methods to the material. With these patterns, one can create sag-reducing structures that do not interfere with the shape conformance of the design. To demonstrate this, four tessellation origami-based structures were tested and showed a 50% decrease in sag, as shown in Figure 1b.

Origami can also be instrumental in improving wicking capabilities. Wicking is the controlled movement of fluid through capillary action, and can improve the absorption capabilities of a diaper when incorporated in the design. Wicking can be enhanced by adding layers of fabric. Adding origami folds to a material also increases the amount of wicking that happens. Tests with different patterns and single and double layers of material showed that all samples with

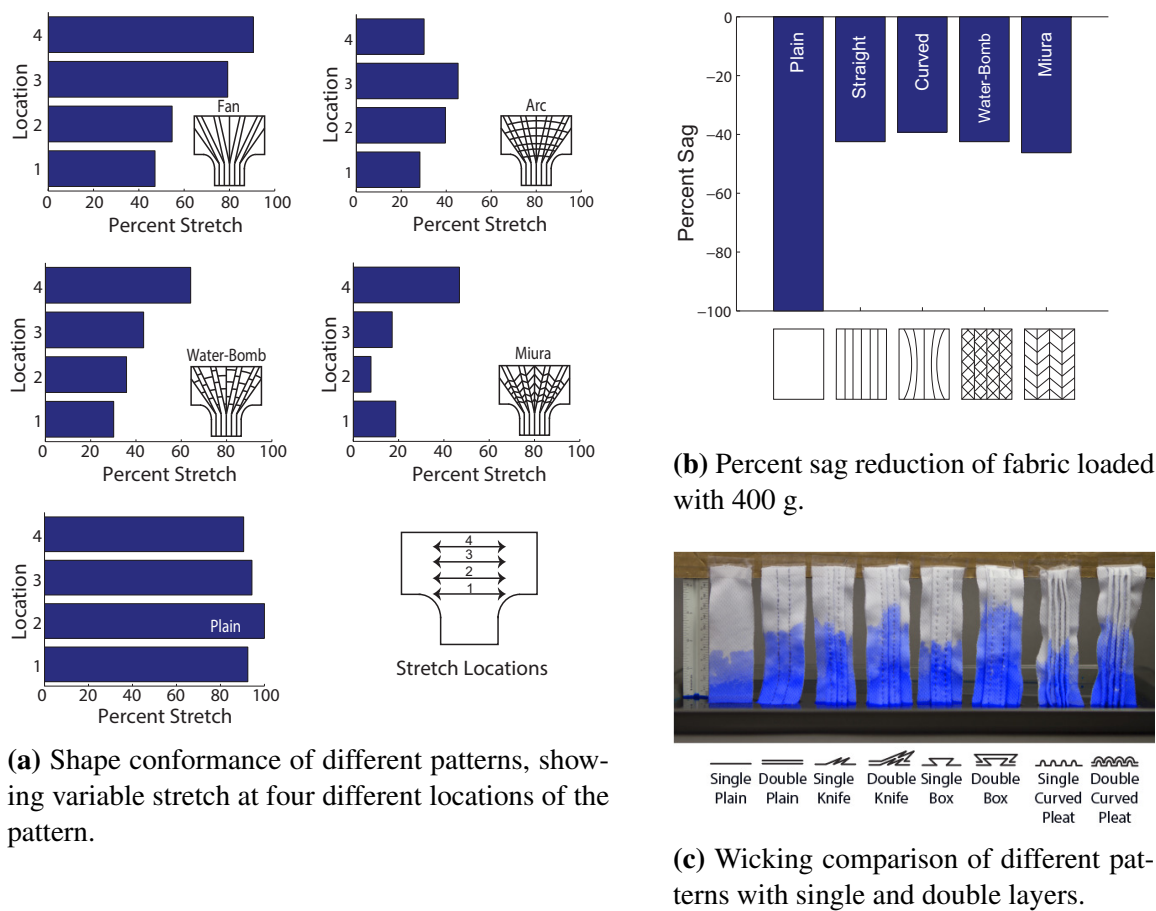


Figure 1: Test results for each of the three areas of needed improvement.

folds performed better than the plain fabric, and most performed as well or better than the plain, two-layered sample without creases (see Figure 1c). Samples with double layers performed better than samples with single layers.

Design elements from each of these areas can be combined into the adult diaper by layering or by selecting patterns that improve behaviors in multiple areas.

While adult diapers were the inspiration for this research, the technology developed may be expanded to other fields such as performance gear and clothing, inflatable structures, inflatable or soft robotics, packaging or casing, feminine products, and packable light-weight load-bearing applications such as tents, chairs, and hammocks.

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