EXPERIMENTAL STUDY OF GLUING AS A JOINING METHOD FOR GARMENTS

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Abstract: *Seams of garments and other textile fabrics are usually sewn. Different adhesive techniques can be used to connect textile materials for special purposes, often to create waterproof seams. Gluing and other bonding methods, however, usually necessitate special machines which are not always available in textile production companies. On the other hand, only few reports about using household adhesives can be found in the literature. This is why this paper reports on tests of different commercially available adhesives which were used to bond diverse textile fabrics. The results show that most of these adhesives are not suitable for creating reliable bonds between most textile materials. Only one of the two-component adhesives under examination which is flexible, but not explicitly suggested for textile fabrics has shown to create sufficient adhesion forces between most textile materials.*

Keywords: *gluing, bonding, seam strength, adhesion.*

1 INTRODUCTION

Sewing is the most commonly used joining technique for textile fabrics. Nevertheless, other bonding methods are already available, from ultrasonic welding to laser welding to gluing. All these technologies have the advantage that they can be automatized.

For smaller textile companies, however, the necessary machines are often not affordable. Even simple adhesive bonding techniques often necessitates special machines. Additionally, gluing of textile material has not often been described in the literature.

One area in which adhesives are often used in combination with textile materials is adding textile RFID tags to garments or other fabrics. Since the tag IC often cannot be sewn to create a connection with the textile antenna, it is glued instead. In a recent article, e.g., the RFID chip was connected with the antenna via embroidery with conductive yarn or conductive glue [1]. Adhesives were also used to cover RFID tags consisting of an antenna from brush-painted silver ink with common IC chip and thus protect them during washing [2], finding that the textile glue showed better shielding performance than epoxy or silicone rubber coatings [3]. Glue-type coatings on RFID tags on textile fabrics were found to be easier to handle and to spread than others, with harder coatings sometimes being preferable due to their ability to prevent the conduction lines from breaking [4]. Similar results were found for a comparison of textile antennas produced by patterning silver-plated fabrics and brush-painting silver ink on cotton fabrics, where the latter showed better results after 10 washing cycles [5].

Few approaches have been made to investigate the use of textile adhesives for bonding instead of coating. Aluminium foils, e.g., were glued on basalt fiber fabrics to create personal protective equipment against thermal and mechanical impacts [6]. Textile-wood composites were created and examined with respect to their mechanical properties, using natural bone glue and a polyvinyl adhesive [7].

Similarly, basalt, lavsan and blended fabrics were glued with a PVC film to create composites with high mechanical and flame-proof properties [8]. Layered fabrics consisting of textile fabrics and membranes were also constructed using adhesives, modifying the diffusion coefficient by diverse treatments [9].

Nevertheless, while the influence of sewing parameters on the seam strength is sometimes investigated for special applications [10, 11], similar investigations cannot be found in scientific literature for glued bonds between textile fabrics. Only the adhesion forces between small electronic elements and diverse textile materials were investigated yet [12, 13].

This article thus gives a first overview of the broad spectrum of adhesion forces which can be reached using different combinations of textile fabrics and nontoxic adhesives which can be applied without machines.

2 EXPERIMENTAL

The textile fabrics used in this examination are depicted in Table 1. The chosen materials are typical for garment construction.

Table 1 Textile fabrics used for the tests

Fabric material	Construction	Areal weight [g/m²]
100% cotton (CO)	Woven	120
100% polyester (PES)	Woven	170
100% linen (LI)	Woven	245
95% CO, 5% elastane (EL)	Knitted	217
95% PES, 5% EL	Knitted	180
65% PES, 35% CO	Woven	105

Three commercially available household adhesives were used and compared with nontoxic, easily applicable industrial adhesive and the force gained by sewing. All adhesives are elastic and specified as water-resistant. The following products were used: textile glue (Bindulin), all-purpose glue (UHU), two-component adhesive (Bindulin), and the industrial glue DELO-DUOPOX® 02 rapid (Delo). The adhesives were applied on the textile fabrics using a doctor's knife and dried according to the respective instructions (Figure 1); the samples with textile adhesive were afterwards ironed at a temperature range of 130-165°C.

For sewing, 100% polyester yarn Ne 40/2 was used in a sewing machine Victoria / model 785 with a single universal needle 80/12, using a double lockstitch with a stitch length of 3 mm. One seam was applied in the middle of the sample.

Five samples of each combination were prepared and tested according to DIN 53530; the results were evaluated according to DIN ISO 6133. Since the sample width is 25 mm, the measured adhesion forces are scaled to a width of 1 cm in the results. No scaling was performed for the sewn samples. This means that in the results, glued seams of 1 cm width are compared with sewn connections of significantly smaller width, which has to be taken into account in the evaluation of the results.

Measurements were performed using a Sauter universal testing machine. For washing tests, a washing machine Bosch Maxx was used, applying heavy-duty detergent (Tandil, 20 ml) and softener (20 ml) during one washing cycle at 30°C for 1.5 h and a spin cycle with 1400 min^{-1}. Washing was followed by subjective evaluation of the samples.

3 RESULTS AND DISCUSSION

Figure 1 depicts a sample series during drying. As visible here, some adhesives were hard to spread regularly on the samples, depending on their viscosity, partly resulting in non-uniformly glued samples.

Figure 1 Textile strips, glued with different adhesives, drying at room temperature

The effect of this problem is visible in Figure 2. Here, both samples with higher adhesion start with nearly exactly identical values. The irregularly glued sample, however, shows significant decreases in the adhesion force, finally resulting in a reduced average adhesion, as evaluated according to DIN ISO 6133. This effect must be kept in mind for possible applications in small companies – adhesives which cannot be applied regularly with typical textile technologies, such as a doctor's knife, are not suited for these purposes.

On the other hand, the blue curve shows a significantly smaller adhesion force. This combination of adhesive and textile material is apparently not suited for industrial application, either.

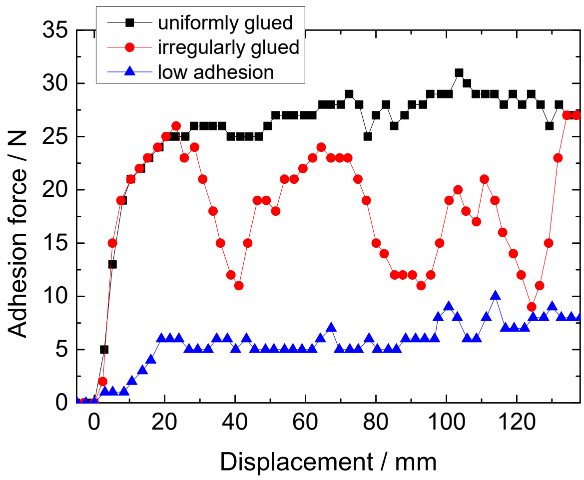

Figure 2 Typical force-displacement curves for different glued samples, either glued uniformly with a high adhesion, irregularly – but with a high adhesion at some positions –, or with a constantly low adhesion

A comparison of the adhesion forces of all material combinations under investigation is depicted in Figure 3. It should be mentioned that for sewing, the absolute force [N] is given, as described above.

Firstly, the all-purpose glue shows low adhesion forces on most textile materials and is thus not suited for gluing textiles. Additionally, the large error bars indicate severe irregularities in the adhesive application. The two-component glue shows similarly low adhesion, on CO and CO/EL near to zero. Interestingly, the bonds created by the textile glue are not much stronger. This finding is in agreement with former experiments gluing electronic parts on textile fabrics [12, 13].

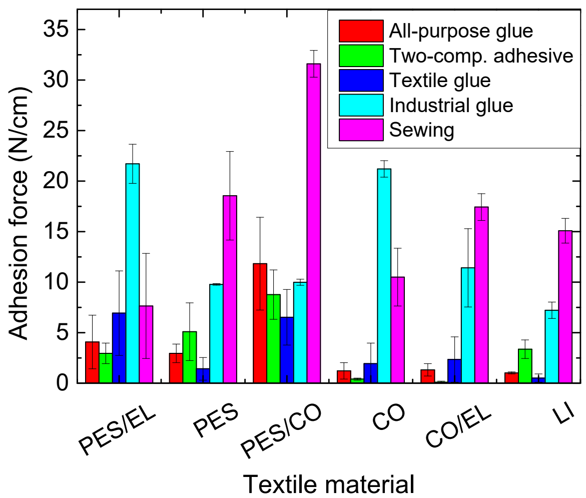

Figure 3 Adhesion forces for diverse combinations of textile materials and adhesives

Sewing leads to adequate seam strengths in all cases, usually with the highest values of all bonds. Nevertheless, the industrial glue gives sufficient adhesion values on all textile materials except PES/CO. The large error bar found for industrial glue on CO/EL results from the textile fabric being destroyed during the tests, without the adhesive being detached. This shows that gluing instead of sewing is principally possible, while nevertheless this decision must be made separately for each material combination.

Finally, it must be mentioned that in this test, a glued seam of 10 mm width is compared with a sewn seam of less than 1 mm width. Although all adhesives are elastic, such a broad seam will definitely modify the bending stiffness and the haptics of a garment or another textile fabric. Even with the industrial glue, unremarkably thin seams are not yet possible.

The results of the washing tests are given in Table 2, with a scale from + (no modifications) to 0 (small modifications) to – (strong or complete delamination).

Interestingly, while the industrial glue and sewing work with all fabric materials, no general trend is visible for the household glues. Apparently, all of the adhesives work well with some materials and have lower adhesion on others. This means that none of the household glues tested here can be used for all textile materials.

Additionally, the best combinations in the washing tests do not correspond to the ideal combinations in the adhesion tests. None of the household glues is thus suitable for producing reliable, washable bonds between textile materials.

Table 2 Results of washing experiments

Fabric material	All-purp.	2-comp.	Textile	Indust.	Sew.
CO	0	0	0	+	+
PES	+	-	0	+	+
LI	+	0	-	+	+
CO/EL	0	-	+	+	+
PES/EL	+	-	-	+	+
PES/CO	0	+	-	+	+

4 CONCLUSION

To conclude, we have compared the adhesion forces of different adhesives and a sewn seam combined with diverse textile materials which are typical for garment production. While sewing and the industrial glue work sufficiently in adhesion and washing tests, the household glues suffer from low adhesion in at least one of the tests.

Future experiments will thus concentrate on testing further flexible industrial glues and increasing the uniformity of the adhesive application with equipment typically available in the textile industry, such as doctor knives or roller squeegees.

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