A NEW JOINING/FABRICATION TECHNIQUE FOR COLLECTIVE PROTECTION: THE DURASEAL™ SEAM

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ABSTRACT

The desirable barrier properties of highly engineered fabrics for collective protection are frequently degraded by the techniques used for joining the fabric pieces. Joining techniques such as sewing penetrate the material barriers with thousands of needle holes which must be resealed to reform the material barrier. With funding from SBCCOM, Clemson Apparel Research has developed a new technique for forming the joint, a Duraseal™ seam. The Duraseal™ seam is formed with a separate heat fusible polymeric film; the configuration of the seam is designed to minimize typical deficiencies in stitchless seams such as reduced peel strength. This paper describes the formation of the seam and presents results of the seam performance on collective protection fabrics.

INTRODUCTION

Materials for collective protection are highly engineered fabrics, frequently with one or more barrier layers. A typical material is shown in Figure 1. This vinyl coated polyester fabric demonstrates good mechanical properties and has proved to be a good shelter material.

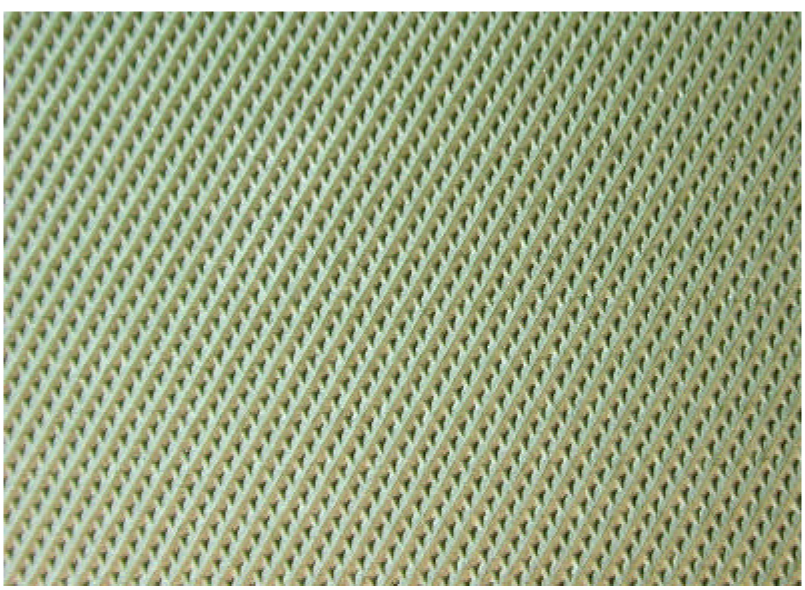

Figure 1 Vinyl-coated woven polyester shelter fabric.

This type of fabric is routinely cut into shaped pieces as part of the shelter fabrication process. The pieces are typically joined together using a sewn seam.

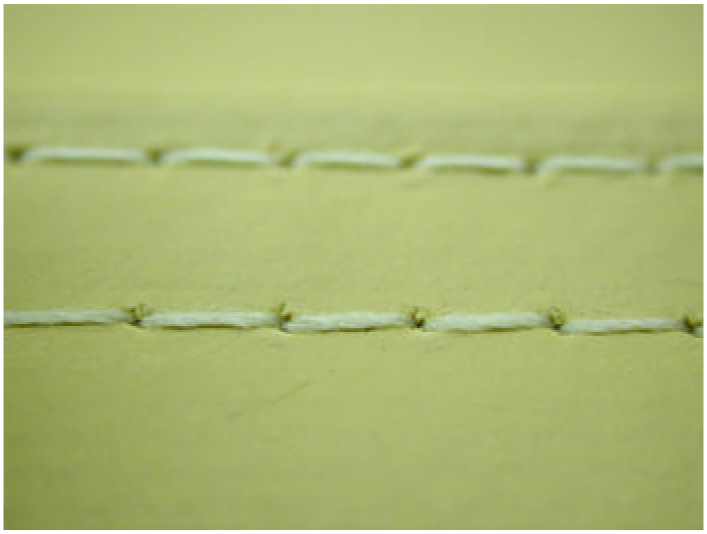

Figure 2 Sewn seam in vinyl-coated polyester shelter fabric.

If the sewing thread is removed, then the needle holes are readily apparent. The needle holes occupy a substantial fraction of the length of the sewn seam.

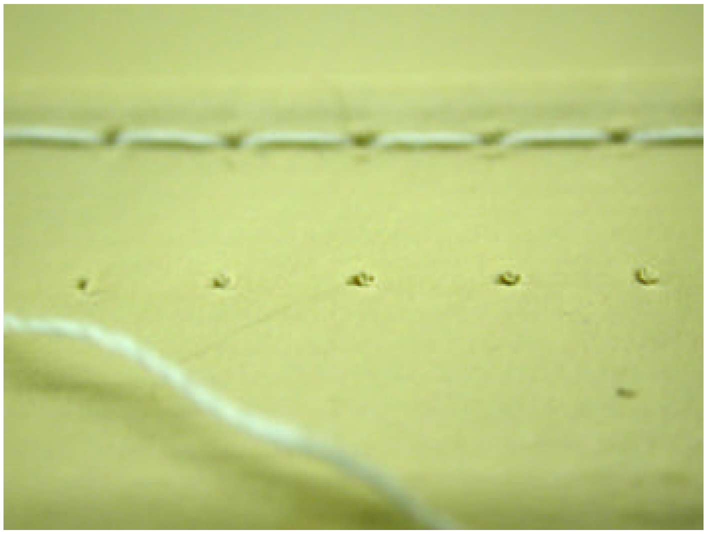

Figure 3 Needle holes in vinyl-coated polyester shelter fabric.

A filler material such as an adhesive-backed fabric tape is used to close over the needle holes in the seam. This step is more time-consuming than the original mechanical seaming process to produce the seam.

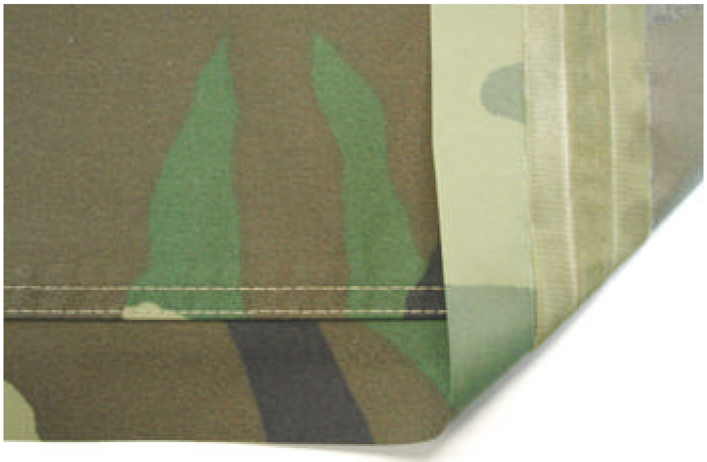

Figure 4 Taping of the sewn seam in a vinyl-coated polyester shelter fabric.

One potential problem with taped seams is their lack of peel strength which leads to delamination of the sealed seam.

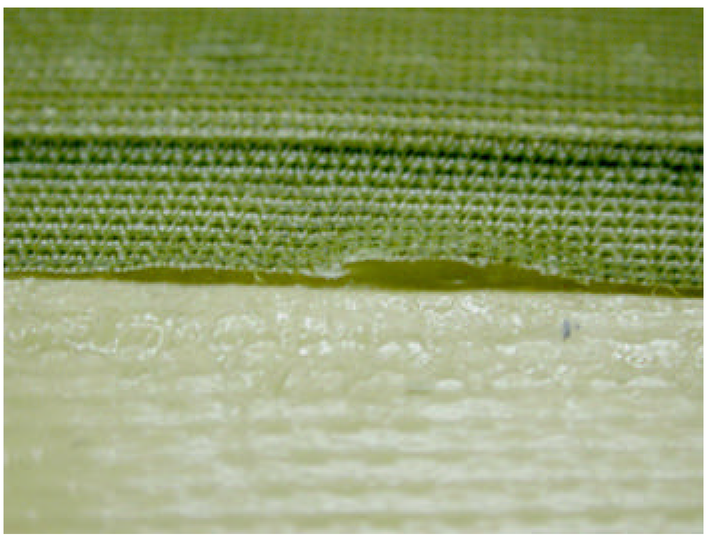

Figure 5 Peeling of seam tape from vinyl-coated polyester shelter fabric.

Stitchless Techniques

Non-sewing or stitchless techniques can be substituted for the sewn seams. Commercially available stitchless techniques include the use of ultrasonics, radio frequency RF (dielectric) welding, adhesives and combinations of these techniques. In general, the techniques all suffer from specificity of the technique to a substrate material and poor peel strength. For instance, RF welding is limited to materials which undergo a change in their dipole moment during the absorption of the RF energy. Halogenated materials such as PVC are the best candidates for this technique. Careful selection of the application process can generally result in seams with grab strength comparable to a sewn seam; that is, the seam strength is often limited by failure of the fabric tensile strength rather than the seam itself. Peel strength problems can sometimes be overcome by the design of seams; seams which cross and seal each other reduce the problem but do not eliminate it.

The limitations of these commercial techniques restrict the flexibility of the collection protection designer, particularly in working with new barrier materials.

The Duraseal^{TM} Seam

Because of the limitations of existing seaming techniques and our need to work with materials with unusual coatings for collective protection, Clemson Apparel Research looked for different seaming techniques which would address these problems. The seam configuration which we term a Duraseal^{TM} seam is designed to be both broad in its application to different substrates and to minimize the peel problem. A Duraseal^{TM} seam is shown in Figure 6.

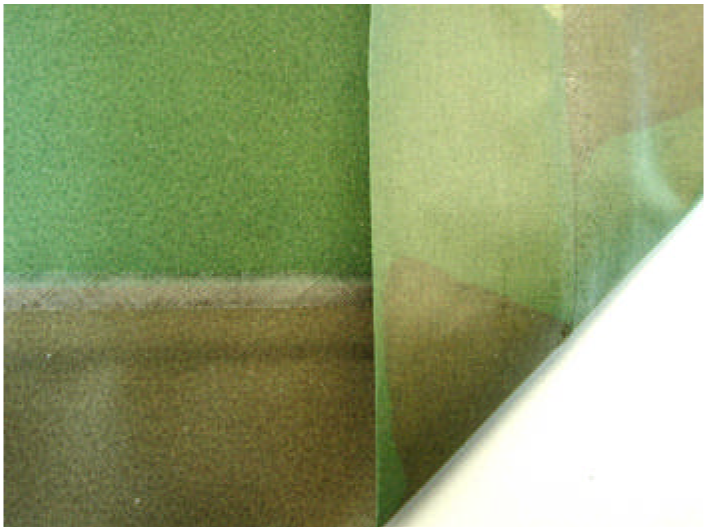
Figure 6 A Duraseal^{TM} seam in a vinyl-coated polyester shelter fabric.

The Duraseal^{TM} seam is approximately one-half the thickness of a typical double needle felled seam (LSa2).

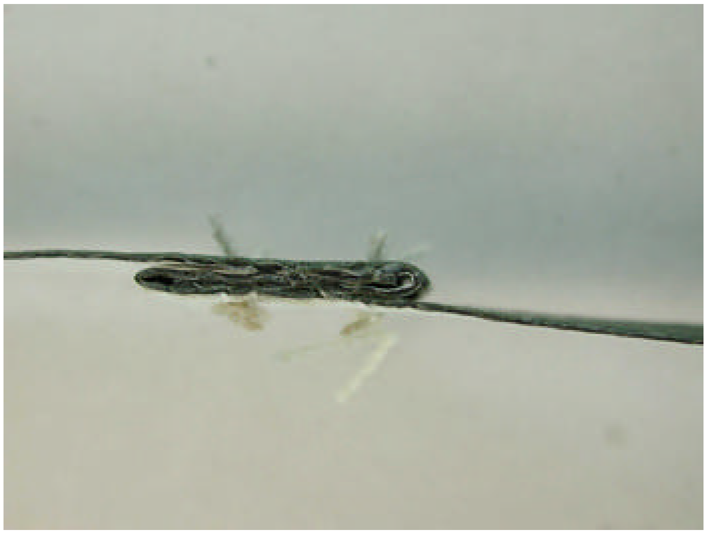

Figure 7 Cross-sectional view of conventional sewn seam (LSa2).

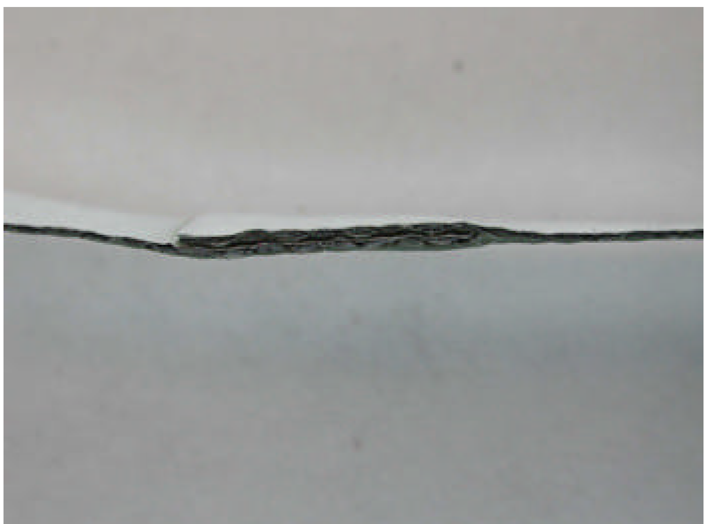

Figure 8 Cross-sectional view of Duraseal^{TM} seam.

One of the reasons for the good peel and grab strengths of the Duraseal^{TM} seam is the penetration of the fusible polymeric film through the thickness of the seam. The polymeric film is heat activated and adds mechanical strength as well as adhesion in the seam area.

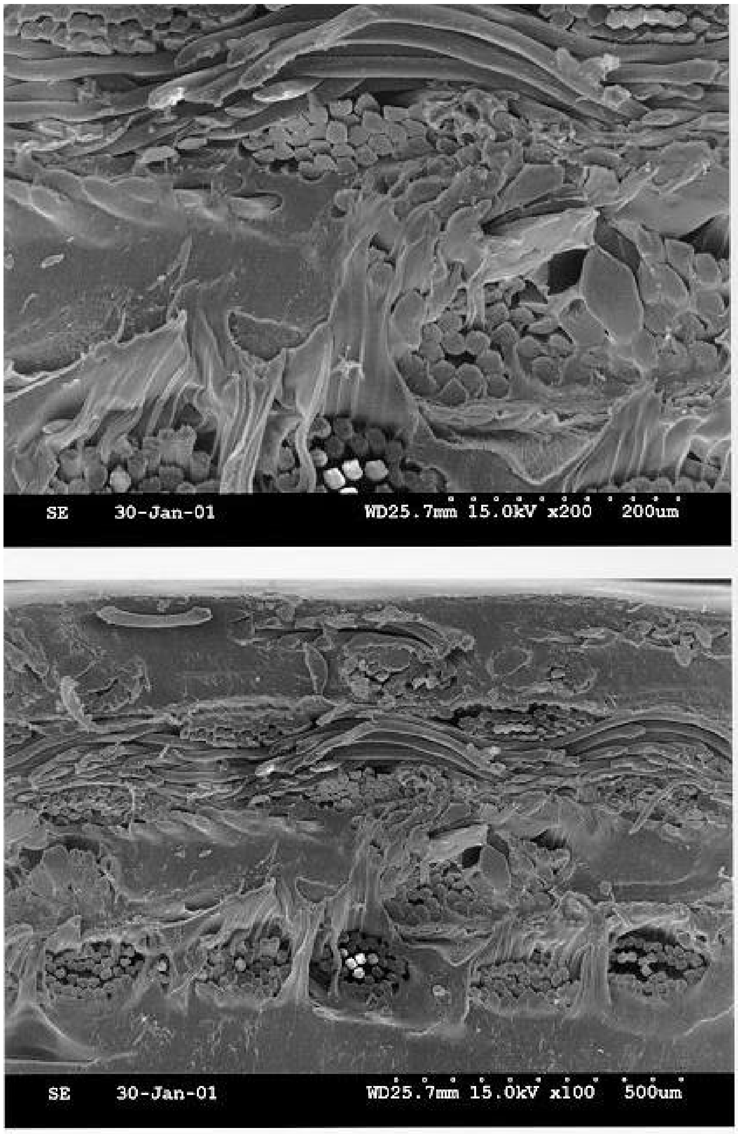

Figure 9 Photomicrograph cross sectional view of Duraseal™ in tri-layer laminate.

<u>Testing of Seam Properties</u>

Samples of a Duraseal™ seam in a laminated barrier fabric for chemical/biological protection were tested in the Netherlands with a challenge of agent HD. There was no penetration of the seam observed during the test time of 24 hours.

Seam efficiency tests were performed on Duraseal™ seams in several coated protection fabrics. Fabrics tested so far include the vinyl-coated woven polyester, a urethane-coated woven Kevlar™ , several PTFE-finished woven fabrics, and a group of silicone-coated woven materials. Values of 85-100% (relative to the fabric strength without the seam) were observed except for the silicone-coated materials. Insufficient adhesion to the silicone-coated materials causes the development of minimal seam strength; selection of a more appropriate film adhesive should address this problem. (In general, there are a limited number of satisfactory adhesives for silicone-coated materials, particularly ones which are compatible with the production of collection protection products.)

Production Processes

Many stitchless production techniques, particularly ones which use adhesives, are only marginally compatible with the production lines and operations used in commercial manufacturing facilities for collective protection. Atmospheric release of solvents, adhesives with long green times before any substantial strength is developed, tacky materials are some examples of properties which are not compatible with the typically dry, high speed processes in manufacturing facilities.

The Duraseal™ seam was designed to address these problems. Formation of the seam requires the use of a dry, polymeric film which is heat fused to the substrate materials. The major limitation of the current process is the time and configuration required for fusing. Commercially available fusing equipment (such as supplied by Queen Light or Seamtek) can be used for forming the seams but the production speed is slow, comparable to taping speeds for these machines. Clemson Apparel Research is continuing to explore other machine configurations which would be flexible but also faster.

CONCLUSIONS

The Duraseal™ technology has been shown to produce excellent grab strength, good peel strength seams appropriate for use in collective protection products. The polymeric film adhesives used to date are compatible with a wide variety of fabrics with the exception of silicone-coated materials. The seams in one protective material show 24-hour holdout of an HD challenge. In addition, the processes necessary for forming the seams are compatible with typical fabrication techniques used in commercial production.

ACKNOWLEDGEMENTS

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