Laser welding – a promising joining method for airbag fabrics

Michael Hustedt, Johannes Stein, and Dirk Herzog, Laser Zentrum Hannover e.V.

L-TEX partners: itg Automotive Safety Textiles, KSL Keilmann Sondermaschinenbau GmbH, LMB Automation GmbH, m·u·t AG, UTT Technische Textilien GmbG & Co.

The most common joining process for mass production in textile industry is sewing. However, there is a growing number of applications in which the traditional sewing process is replaced by welding, e.g. hot air, hot wedge or ultrasonic welding. The joining of upholstery is an example for the successful integration of a textile welding process into a production process of the automotive industry.

In general, welding is possible, if the fabrics are made of thermoplastic materials, which can be molten without destroying the polymeric molecular structure. This is usually the case regarding technical textiles. The joining of airbag fabrics – made of PA 6.6 (nylon) or PES (polyester) – is a challenging welding application. Today's safety standards for automobiles include the availability of various airbag types, i.e. driver and passenger airbags, side-impact airbags, inflatable curtains, seat and door-mounted airbags, etc. The development of welding techniques for airbags is stimulated by the airbag industry due to important drawbacks of the sewing process, e.g. seam leakage behaviour, occurrence of stitch errors as well as limited degree of automation. However, the requirements on the seam strength are extremely high (1,000 N/5cm according to a tensile test specified by DIN EN ISO 13935-1) and so far cannot be fulfilled by conventional welding.

In this work, an alternative technology to join airbag fabrics, known as laser transmission welding, is demonstrated using polyamide 6.6 fabrics as an example. The laser radiation irradiates the textile layers positioned and pressed together in their final alignment. The radiation transmits the upper layer and is absorbed in the joining zone, thus being converted into heat. Due to this local heating, material near to the joining zone is molten, forming a connection between the textile layers. Moving the laser across the airbag layers, a weld seam is generated along a programmable contour. The described process can be integrated in automated production lines, the flexibility is high considering new airbag geometries, and the quality control may be realised by pyrometric or camera-based optical instrumentation.

The influence of different process parameters on the seam strength as well as aspects of seam construction and quality control are shown. Most relevant to reach the required seam strength is the usage of an appropriate absorbing polymeric interlayer material, placed between the airbag layers to be joined, to allow for generating a weld seam while preserving the textile fibres to a large extent. In addition, the seam construction has to be adapted so that in case of explosive inflation of the airbag, shear tensile stress arises instead of peel stress. Regarding technical aspects of the laser welding process, a prototype system has been built up.

In the future, laser transmission welding of thermoplastic fabrics may complement or replace sewing techniques used so far to manufacture airbags, but even for production processes outside the automotive industry, i.e. for protective clothing, curtains, large-area tarpaulins, parachutes, etc, it may be a promising alternative.

Keywords: laser welding, technical textiles, thermoplastics, airbag, seam strength, seam construction, polymeric filler material

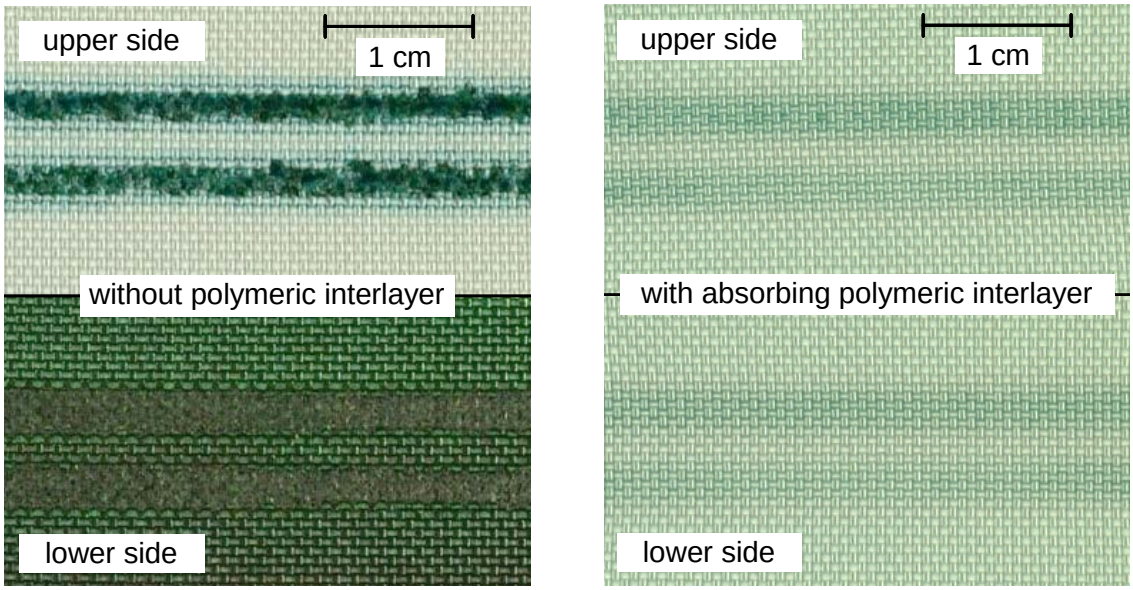

Figure 1: Laser-welded airbag fabrics (PA 6.6), left: without polymeric interlayer (lower layer directly coloured), right: with absorbing polymeric interlayer.

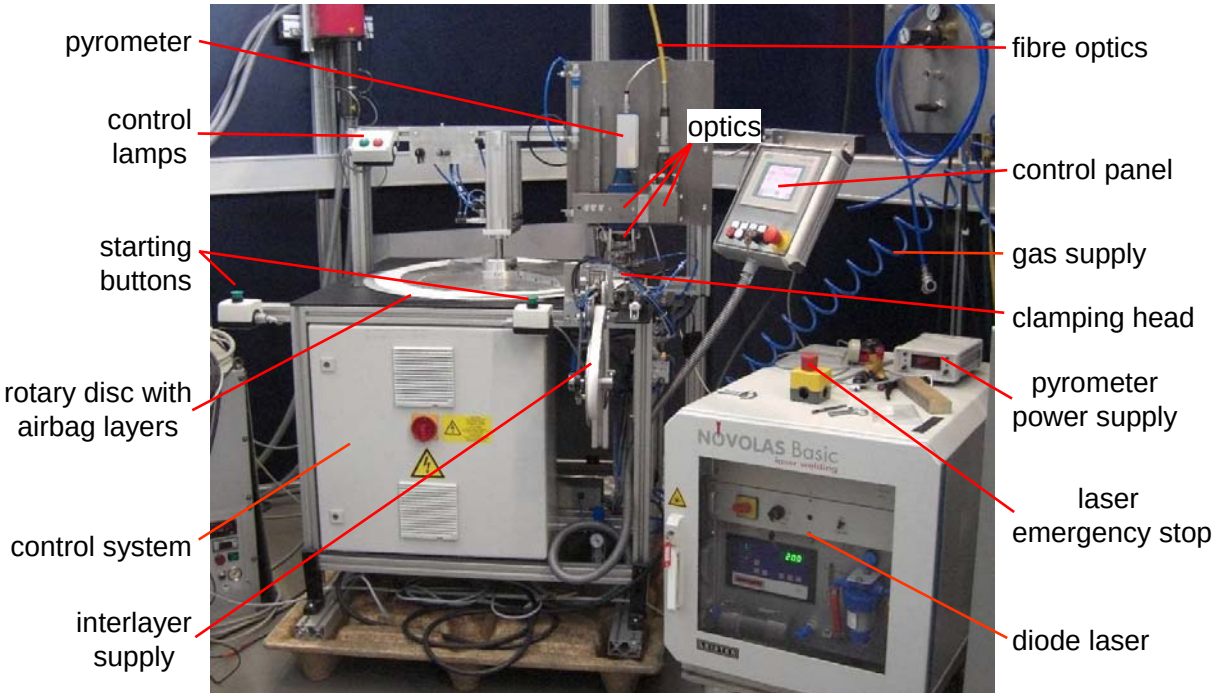

Figure 2: Prototype system for laser welding of airbag fabrics used for driver airbags.

funded by
Federal Ministry of Education and Research
managed by
Project Management Forschungszentrum Karlsruhe (PTKA)