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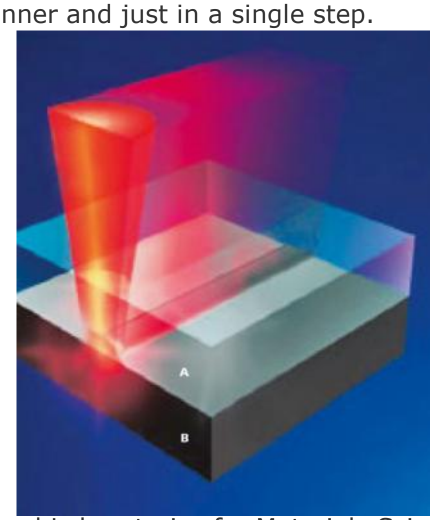
Are lasers replacing sewing for clothes?

Needle and thread that is how clothing has been manufactured for thousands of years. S ewing is however not quite so handy, when clothing has to be water - or even air-proof as needles pinch tiny holes. Welding textiles with a laser seems to be an elegant way of solving the problem. Swiss Empa researchers have found new ways.

Looking back, fish bones or needles made of bone, horn or ivory used to be fashionable, but today they have been replaced by high-precision metal industrial sewing machine needles to make garments at a speed of 10000 stitches a minute. But no matter how thin the needles, the all pinch holes in the textile surface structure. This means that for instance, rain ca n penetrate the seam of an outdoor jacket. To prevent this, seams are then glued together in a second step. A long established joining technique from the metal and plastics industry, welding now makes this lengthy two step process a thing of the past. A d iode laser welds textiles in a completely non-permeable manner and just in a single step.



According to Empa (Swiss Federal Laboratories for Materials Science & Technology, belonging to ETH, the Swiss Federal Institute of Technology) has developed such a welding process for clothes. The principle of laser welding is simple: a laser beam heats up the metal or thermoplastic so intensely that it melts in places an d the materials become fused. A diode laser now does the same with textiles made of polymer fibres. A laser beam penetrates a transparent textile layer. The underlying loayer absorbs the beam's energy and transmits it back to the transparent layer. The two layers then heat up along the beams for welding and the polymer chain of the textile layers melt gogethter. Textile engineer and project leader Alexander Haag from Empa's Laboratory for Protection and Physiology explains the advantages of such a process: "You just cannot beat joins on the molecular level".

But researchers had to overcome some stumbling blocks. One of them is the nature of textiles.

Textiles are "limp". Their form is unstable and they can form creases involuntarily. They are thin and can quickly become overheated by the laser and the textile will be damaged. Different "Textile surfaces", as the expert calls them, also behave differently during processing. Because of their stitches knitted and crocheted fabrics are trickier candidates than "smooth" fabrics.
A further challenge is that the laser beam cannot cope with some black materials. What the human eye sees as black, for instance light-absorbing, is almost transparent for the laser which functions in the infrared part of the spectrum. Prior to welding, it must be clear, whether the textile surface is really suitable for laser welding in terms of its absorption, reflection and transmission pro perties

Alexander Haag is currently modifying all the process parameters to identify the best techniques for welding various layers together. Towards the end of the year, when the project financed by the Commission for Technology and Innovation (CTI) wil l be completed, a welding method should be available, joining different thermoplastic polymer fabrics with up to 10 micrometer-thin membranes made of polyester or polyurethane in a lasting and tight manner. To this end, the Empa team is developing two diff erent diode laser welding facilities together with their industrial partners, namely Leister Technologies AG, in Kägiswil (CH), Unico Swiss Tex GmbH, Alpnachstad (CH), Schips AG, Tübach, Schoeller Textil AG, Sevelen, Serge Ferrari Terrsuisse SA, Emmenbrück e and the Swiss Textile College Zurich (all CH). The result will be a laser sewing machine for quasi infinite joining, and a facility for joining complex structures on one level in all directions.

According to the Empa textile expert, the new joining techn ology opens up entirely new possibilities. "As laser welding is more closely related to computer -aided construction than a conventional sewing machine, the action can be very precisely controlled just like in technical construction" explains Haag. He adds: It lends itself not only to straight, but also complicated, curvy welded seams and even to 3D constructs." These are needed, for instance, when the design includes valves to introduce air between two structures. By means of simple control, it becomes relatively easy to weld airtight and watertight seams for outdoor jackets and larger textile areas made from various superimposed ultra -thin layers of material using precision lasers. Another advantage of the welded seams, according to Haag is "that they feel pleasant on the skin as they are very soft".

Empa scientist Markus Weder and his team have already demonstrated in a number of projects that laser welding is particularly well -suited to combining textiles with ultrathin membranes. For instance the clothin g developed for MS multiple sclerosis patients with Unico swiss tex GMBHJ, is already established in the market. Cooling pads made from ultrathin polyester membranes are built into their shorts and T -shirts. Weder explains how this works: The cooling clothing consists of three layers. Two 10 to 15 micrometer -thin polyester membranes make up the inner and outer layers. Between them is a crocheted fabric, about 100 micrometers in thickness creating a cavity between the membranes. It can be simply filled with tap water. The winning argument is: The membranes are watertight, but permeable for water vapour. The water evaporates on the outside and the wearer has a pleasant cooling feeling on the skin."

As a next step, the textile engineers want to present an ECG b elt with welded-on, wettable elements for the long-term monitoring of cardiovascular patients, which they have developed in another CTI project. It has been especially designed for elderly people who don't perspire so much anymore. Last, but not least, the researchers are working jointly with industrial partners on medical support stockings that don't have to be tugged on with great difficulty, because these can be "pumped-up£" with air. The icing on the cake is the variable pressure in the (multi-ply) stockings can be used for monitoring purposes too. A measurement device can provide information on how frequently the patients move around.

This article was published by EMPA.
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With our best regards
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