

# A further step towards automated shoe production

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Despite the many technical advances made in recent years, many processes in shoe manufacturing are still performed manually. For example, bonding the outsole to the shoe upper is still usually done by hand. However, wages in today's Asian shoe producing countries are rising disproportionately and, as a consequence, manufacturers and brand owners are increasingly interested in automated processes. Automation would also enable them to consider relocating production from Asia to where the shoes are sold. In addition, automation enables producers to guarantee a consistently high standard of quality.

As one of the world's leading suppliers of high-quality polymer materials for the footwear and textile industries, Covestro has its sights firmly set on this trend. The company's technicians have now developed an innovative concept with which the outsole can be automatically and efficiently bonded to the shoe upper in an environmentally friendly way. An essential component of this new concept is the use of an adhesive filament and 3D printing as a new method of sole attaching.

## SELLING & MANUFACTURING BECOMES ONE

The concept also makes it possible to create a shoe store of the future. ATOMLab, the research and innovation division of the shoe machine manufacturer ATOM, presented a new system called RoboShop at Simac earlier this year in which a 3D scanner measures the customer's foot profile. Using this data, the system then individually combines shoe shape, design, upper materials, colour and sole on a computer and displays the configured shoe on its screen. One click is then sufficient to light up the required



*A special printer head attached to a robot arm applies hot melt adhesive off a roll.*  
CREDIT: ATOM

last and shoe components on a shelf displayed on the screen.

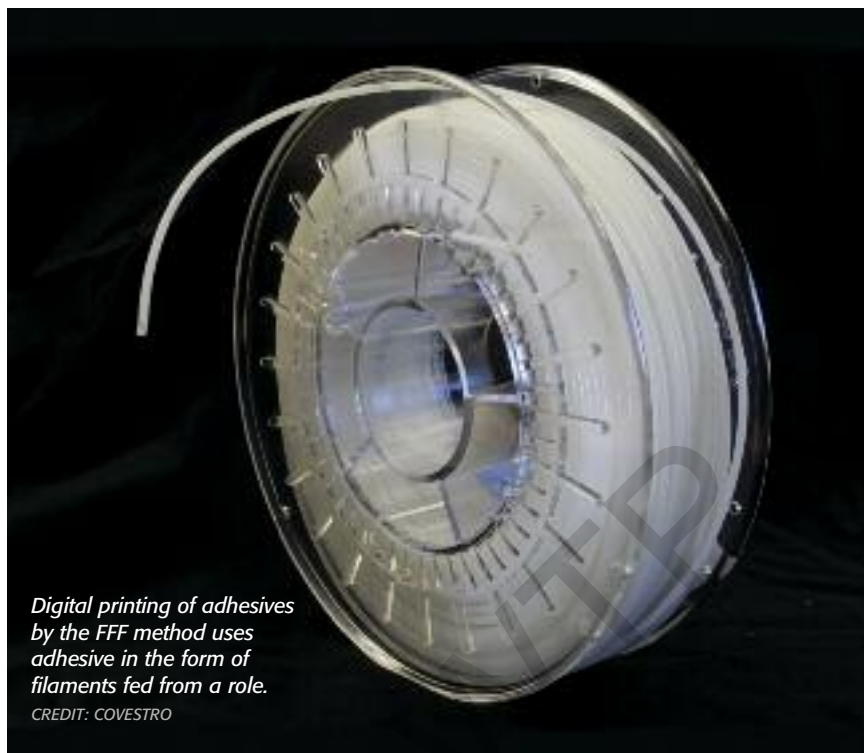
Using the selected upper and components, the shoe is then processed up to the stage where the sole is to be attached, from which point the process continues automatically. A robot arm moves over the shoe bottom following a

digitally defined pattern and applies the molten adhesive. Another robot arm grips the outsole and presses it onto the shoe upper a few seconds after application of the adhesive. After a short time, the upper and sole are firmly bonded and the customised shoe is complete.

## MODIFIED 3D PRINTING TECHNOLOGY

The robot arm is equipped with the print head from a 3D printer. A filament of adhesive is briefly melted in the print head which then applies it according to a specified print image onto the selected surface. This process corresponds to the Fused Filament Fabrication (FFF) process, also known as Fused Deposition Modelling (FDM). Unlike this 3D printing process, however, the application of the adhesive is aborted after one or two passes and the working plane does not move upwards. The result is not the normal three-dimensional body but, instead, the adhesive is applied two-dimensionally to a 3-dimensional surface. While the two parts to be bonded are pressed together, the adhesive cools down, crystallises and a firm and durable adhesive bond is created.

To date, Covestro has offered adhesive producers PU dispersions for aqueous adhesives and raw materials for PU reactive hotmelts. Each technology has its own specific advantages for the shoe industry.



*Digital printing of adhesives by the FFF method uses adhesive in the form of filaments fed from a role.*

CREDIT: COVESTRO

Aqueous PU adhesives are characterised by a high initial and final strength and adhere very well to most natural and synthetic materials. They facilitate, for example, the bonding of an outsole to a

shoe upper that meets the highest demands for long-term stability and quality. They are also user-friendly and preferable to solvent-based systems for reasons of occupational safety.

A large advertisement for CORDURA fabric. The top half features a photograph of a person in mid-air, jumping over a cityscape. The person is wearing a dark tank top, dark shorts, and bright yellow sneakers. The city below is a dense urban area with many buildings. In the top right corner of the image, there is a black box with the CORDURA logo and the word 'Fabric' underneath it. The bottom half of the advertisement has a dark, textured background. On the left, the text 'A DURABLE WORLD AT YOUR FEET' is written in large, bold, orange letters. Below this, in white, is 'ON THE TRACK, STREET, SITE OR BATTLEFIELD'. At the bottom left, in a white script font, is 'CORDURA. LIVE DURABLE.™'. On the right side, there is a block of white text: 'Wherever the challenge, you'll find footwear made with CORDURA® fabrics. Engineered to deliver enhanced abrasion resistance and tear strength, with exceptional strength-to-weight ratio. Worn by people pushing their limits - in the field, on the job, in the urban jungle.' Below this, in white, is 'Live versatile. Live tough. LIVE DURABLE™'. At the bottom right, there is a white box containing the text 'CORDURA.COM' followed by social media icons for Twitter, Facebook, YouTube, LinkedIn, and Instagram. Below this box, in small white text, is '© 2018 INVISTA. CORDURA, the CORDURA logo and LIVE DURABLE are trademarks of INVISTA.'

Heat activated dispersion adhesives based on polyester polyurethanes are widely used in the shoe industry. After such an adhesive has been applied, it must first dry. In this state it is not sticky but becomes so after the crystalline polyester segments of the polymer have melted at a temperature between 60° and 80°C. The upper and sole must then be joined within a few minutes, a period of time during which the dispersion adhesive still has sufficient tack and flowability (hot tack life). Without heat activated PU adhesives, the highly complex sports shoes currently available would probably not exist. Nevertheless, the necessary steps of drying and reactivating cost time and energy, and make automation of the bonding process more difficult.

Unlike PU dispersion adhesives, PUR hotmelts are solid at room temperature. They only become flowable at a comparatively high temperature above 100°C and are therefore applied from a heated storage tank. Their big advantage is that they do not require drying after

they have been applied to the shoe components. However, the high processing temperature is a drawback—which is why their use is limited to temperature insensitive substrates—and results in comparatively low initial strength. In fact, while PUR hotmelts are used in shoe production, it has so far only been on specific materials and shoe shapes without high retractive forces such as flat soles.

### INNOVATIVE ADHESIVE FILAMENT

In the FFF process, the wire-shaped plastic is routinely heated to a temperature above 200°C in order to liquefy the material very quickly in the small volume of the print head and print it onto a substrate. The technicians at Covestro have now developed an adhesive filament whose behaviour is adapted to this processing method. The new polyester PU has a polymer structure similar to that of aqueous dispersions. For application purposes, it only becomes sufficiently fluid at relatively high temperatures. Even so, its structure still remains

sufficiently stable during brief heating.

For example, if the outsole and shoe upper are pressed together after the adhesive has been applied, the join has a high initial strength due to the high molecular weight of the adhesive. Due to a slightly delayed crystallisation, these new adhesives also have the 'hot tack life' of aqueous dispersions. This means that once the molten adhesive has been applied, there is sufficient time to press the sole and shoe upper together without prior activation.

The new adhesive filament in combination with the FFF process combines the advantages of PUR hotmelts with those of PU dispersion adhesives. It can be applied in the same way as a hotmelt and requires neither drying nor heat activation. It can be used to cost-effectively accelerate and automate the bonding process. At the same time, laboratory tests indicate that the resulting bonds are of similar quality and durability as those based on PU adhesive dispersions and peel resistance values were well above the minimum requirements for shoe sole adhesion. 

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