Whitepaper

Envalior
Imagine the Future

EMBRACING SUSTAINABILITY IN THE SPORTS SHOES MARKET

Although advanced recycling technology is on the horizon, biobased materials with the right performance can be utilized.

Climate change, plastic waste and depleting resources are three important environmental themes for the selection of materials. Solutions can be offered with low carbon footprint by using materials, which preferably are recycled or biobased.

An increasing number of governmental and corporate targets reflect the urgency for producers of materials and goods to act now. An even stronger driver is customers awareness of sustainability, which will have an increasing impact on selecting product. However, a customer will expect materials with high performance when the initial materials are of recycled or biobased origin.

In a circular economy, two cycles can be distinguished. One where re–use and re–furbishment are applied to enhance use–time and reduce pressure on resources. The other, where materials manufacturing of virgin quality is needed. Both cycles will ultimately be needed in the future.

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Recyclable or biobased engineering materials are a must for sports shoe midsoles

Making sustainable sports shoes

Offering a recycling possibility is of high importance. It is possible to develop a shoe with biobased materials with the right performance.

Advanced recycling for midsoles

Envalior produces Arnitel®, a soft thermoplastic co–polyester material, for use in durable high energy rebound mid soles for performance sports shoes.

In the figure below, an illustration of a circular economy is shown with a circle denoting re–use, refurbish and repair as the most desired route. This acknowledges that high performance materials also require a recycling option. The outlet as waste, as land fill or incineration, should be avoided as much as possible.

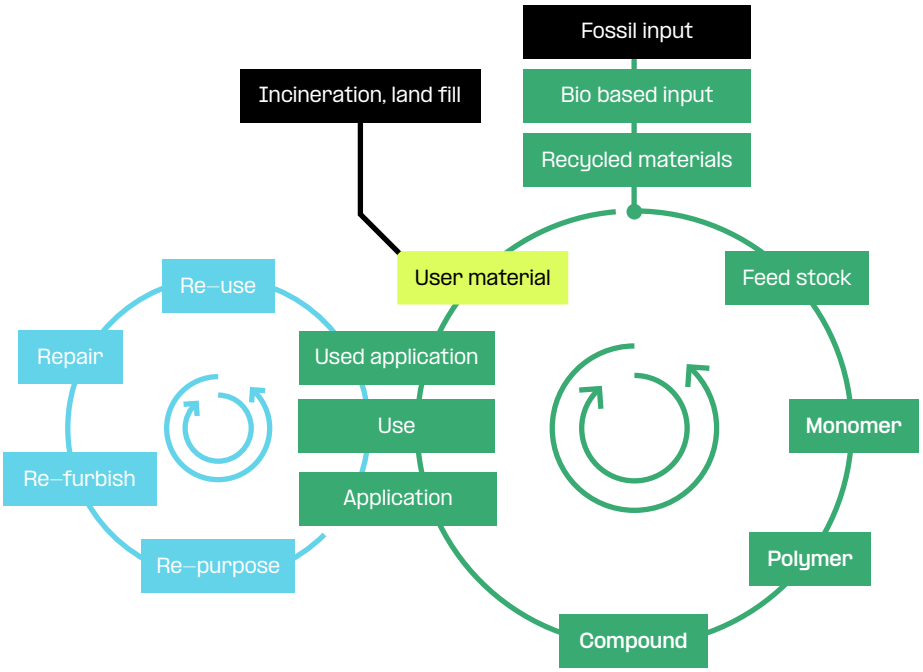


Illustration of the two circular economy cycles based on direct re–use (blue) and recycling (green).

We recognized the environmental trends many years ago, and currently we are able to supply materials based on recycled and/or biobased feed stocks.

Sport shoes are products largely based on polymers, where performance is key as they are used for diverse and demanding trainings or matches.

Shoes have a relatively short use time, and brand owners implement technical improvements and follow fashion in rapid cycles. Once at the end–of–use, a sports shoe is difficult to repair, re–use or refurbish. Therefore they frequently end up as waste. In view of our environmental challenges, recycling of shoes is apparent and recyclability will be required. Initially high–end technologies, like energy recovery foams, will become mainstream.

For material companies it is a challenge to drive this change into a circular economy while doing so in an economically attractive way for customers. Clearly, we are at the brink of a major change in materials manufacturing, waste handling, and in doing business.

Envalior produces a variety of engineering materials, which many can be applied in sport shoes. We recognized the environmental trends many years ago, and currently we are able to supply materials based on recycled and/or biobased feed stocks. Our carbon footprint is strongly reduced by utilizing renewable electricity for our manufacturing process. The carbon footprint from the procured raw materials is monitored and by supplier selection reduced while keeping a balance between cost and carbon footprint.

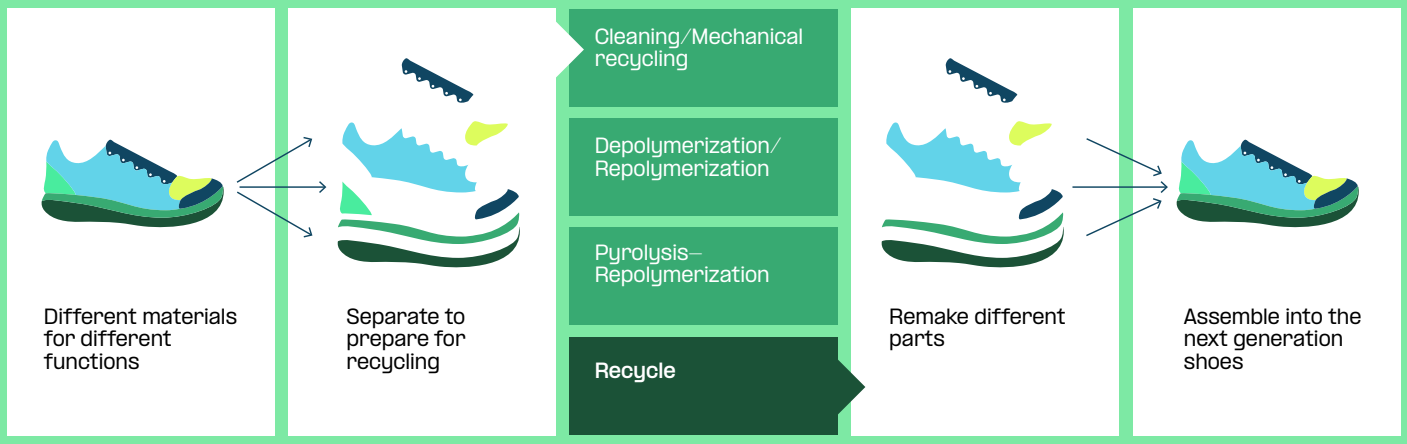
SUSTAINABILITY CHARACTERISTICS YOU NEED TO CONSIDER

A sustainable sports shoe will primarily have a performance designed for the required activity, but sustainability parameters become more of a differentiator. As the use time is relatively short, offering a recycling possibility is of high importance, more so than the use of biomaterials, recycled material from other sources or a low carbon footprint. On the other hand, when investigating in the manufacturing footprint of shoes, carbon footprint of certain elements may become an important factor as well.

YOU MAY FACE CHALLENGES WHEN RECYCLING SPORT SHOES

A shoe is a complex product with several demanding functions. For sports shoes this usually requires a combination of different materials, such as soft abrasion resistant outsoles, midsoles with high energy rebound, and tough toecap breathing to remove moisture. As a "single–material" shoe, it will not have the combination of (sometimes conflicting) ideal use properties required for every part of the shoe. A recyclable single material sports shoe is not an ideal solution.

Collecting used sport shoes is currently complex. Dismantling shoes and sorting them into the many different used and deteriorated materials, is a challenge. Re–use of these individual materials in new sports shoes, which require the same demanding properties at the same low cost as the initial ones, is practically impossible. Closed loop recycling is not logical. Mechanical recycling of the whole shoe into different, less demanding applications is limited and difficult due to the versatility of materials used by different brands and for different sports. Therefore, to recycle sport shoes a different concept is needed.



An illustration on the complexity of recycling used sports shoes. Various materials are applied with properties matching the function. After use, a shoe can be taken apart and different parts can be treated by suitable recycling methods. The resulting materials can be converted for application in the next generation shoes.

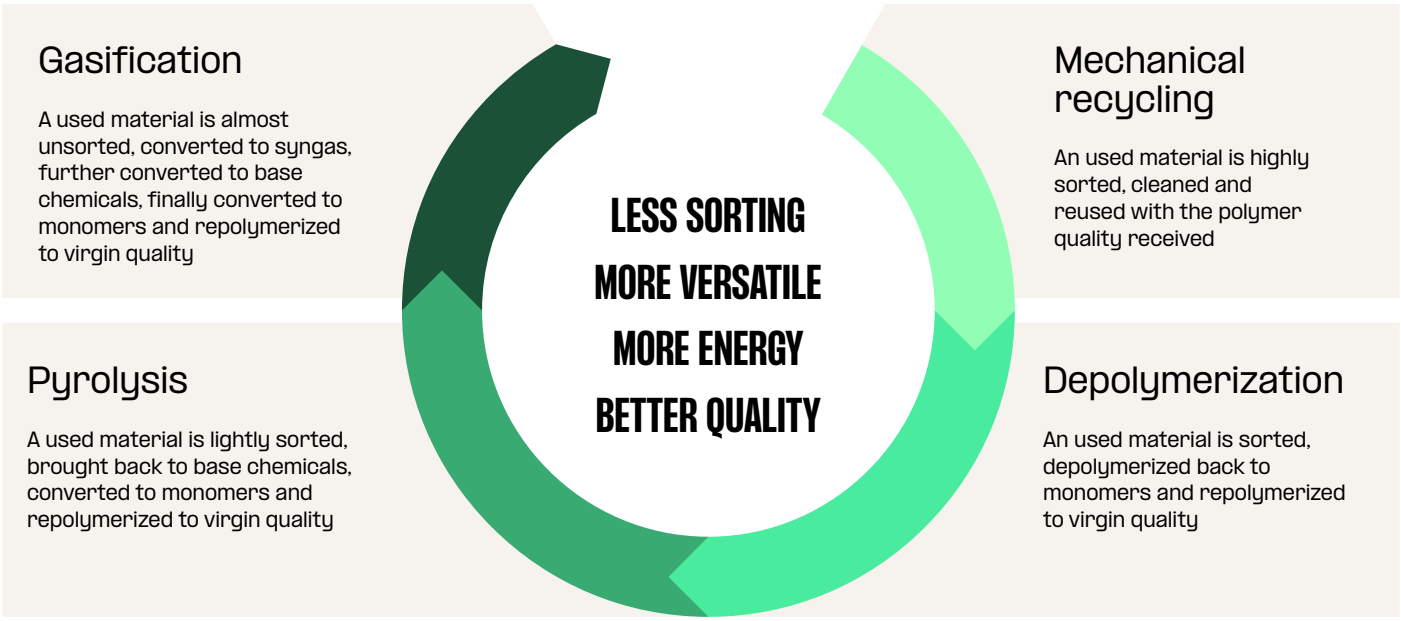
COMPANIES ARE INVESTING IN *ADVANCED RECYCLING TECHNOLOGY*

With the complexity sports shoes require, a versatile recycling technology is required. Currently there is a lot of development to use advanced recycling: bringing materials back to a virgin feed stock and use and then rebuild materials.

The technology to do this is still not widely employed, but it is in development. Large industrial companies invest in research and development to make the production of virgin quality materials from used plastics possible. For example, a variety of plastic waste from packaging and textiles can be used, in sport shoes and other applications.

Advanced recycling currently requires significant energy, which leads to a relatively high carbon footprint, but it is always significantly less than incineration. However, technology development is focused on accepting a more versatile input, creating better applicable output while reducing the footprint.

This facilitates logistics and lowers the energy need. Currently, advanced recycling technology is in a scale–up phase, but the real breakthrough to large scale availability is expected around 2030. For example, technology of Plastics Energy, Mura, Encina and other technology providers are still in early development or in a pilot phase. Cooperations with chemical companies are being made and led to announcements on investment plans.



The above illustration shows various recycling options are known and dependent on quality requirements, type of polymer, ease to sort and energy cost as a method is selected. All options have merits and are needed in the future.

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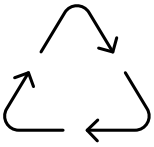
WHAT YOU CAN DO TODAY *TO MAKE SUSTAINABLE SPORT SHOES*

When we move away from fossil input, recycled materials are an option. One can also develop biobased materials with the right performance.

Biobased materials may come in textiles (e.g. cotton) or as filler, but generally they will pass a conversion process to make plastics. Envalior already sells products based on partly biobased monomers.

Another option is to use a comparable technology as advanced recycling and feed with biomaterials. Typically, tall oil or other oils are mentioned and used to produce such materials by using the mass balancing principle. In those cases, the existing infrastructure is applied which facilitates the implementation at low cost.

As shown in the illustration on pg. 4, there are many options to make a sports shoe more sustainable:



Recyclability

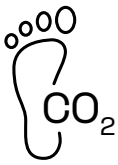
At the end of use of a sports shoe, it can be partly recycled by dismantling and using the remaining materials. This mechanical recycling requires a lot of collecting, sorting and separating effort, but generally leads to products with down cycled properties and these cannot always be reused in new shoes. Advanced recycling technology is in development and will be available in large scale ~2030.

Recycled materials

The use of advanced recycled materials will depend strongly on availability. As these technologies are being scaled, the sports shoe based on recycled materials is coming into sight.

Biomaterials

This is the easiest option if biomaterials are fed to an existing production facility using mass balancing. As this is simplier than recycling materials, it is already easy to convert current fossil–based products into a biobased equivalent. This is already available for most monomers and the availability will increase.



Low carbon footprint

Consumers are aware of environmental impact of cloting and shoes, therefore it is key to focus on reducing PCF. At Envalior, we use low PCF ingredients and improve manufacturing and logistical processes. By further processing the materials into required shapes, the footprint of a shoe may increase.

RECYCLING A MIDSOLE *MADE WITH ARNITEL®*

Envalior produces a soft thermoplastic co–polyester material, branded as Arnitel®, for use in durable high energy rebound mid soles for performance sports shoes worldwide.

Advanced recycling will be the technology of choice for recycling of these materials. The recycling of sports shoes by other methods, like mechanical recycling, is conceptually beneficial from carbon footprint perspective, but it will not likely take over the market for "virgin" materials. If we take the midsole of Arnitel® as an example, the collection and return logistics of sports shoes are essential to enable recycling.

Brand owners are in an ideal position to set–up return logistics for sports shoes to avoid them ending up in household waste, requiring inefficient sorting. The dismantling of shoes down to nearly clean Arnitel® is the next complex step as the material should be "pure" enough for reuse in new, high performing sports shoes. Generally, like with other used polymers, the use–phase and dismantling will change properties, which will not allow for use in the next generation of midsoles. The materials obtained should then be downcycled into new products with less stringent property requirements and with less value. This will not drive towards sufficient availability of materials needed for new sports shoes nor the economic push to develop. Therefore advanced recycling will be the technology of choice for sports shoes materials recycling in the future.

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