

End of the road for EVA?

EVA (ethylene-vinyl acetate) has been the material of choice for sports shoe midsoles for more than 30 years. Over the same period, sports shoe brands have constantly sought to find ways to differentiate their products in terms of performance from their competitors in a cut-throat global market. These have included metallic springs, sealed or pumped air systems and even jel bags, all of which were claimed to improve the shock resistance and 'bounce' of the sole.

As marketing ploys they worked on the basis of "look at me, I've got the latest performance technology in my shoes", until the next new gimmick appeared when the one-upmanship started all over again. Whether any of them entirely met the performance claims made is open to debate. Furthermore, the majority of shoes in what was a huge market by volume, were middle and low grade products where simple EVA remained the main source of comfort and bounce.

EVA was a known quantity; it performed adequately for the vast majority, it was lightweight, easy to process and bond, reliable and competitively priced. As a consequence, many manufacturers and brands continued to use it and in most cases still do. This is not to say that leading brands abandoned the search for better alternatives. Nor, indeed, did the chemical companies and it is from this source that two possibilities have appeared, one of which in particular could provide a real challenge.

POLYOLEFIN

Polyolefins are produced by the conversion of ethylene into polyethylene using catalyst systems based on what are called metallocenes which, in turn, are based on transitional metals such as zirconium that have several ligands (neutral molecules that

bond to a central atom), usually cyclopentadienyl compounds, attached to the metal. They have been developed and increasingly refined over the past 20 years by companies such as Dow and ExxonMobil to become practical soling materials for footwear and sports shoes in particular.

They have a natural low density, can be made in a wide range of hardness and blown to very low density without rapid loss of properties. They also blend easily with EVA, are soft and comfortable and, increasingly important, are easy to recycle. Despite all these positive features, they have not been widely taken up by the industry for several possible reasons.

One is that they are still regarded as being very novel materials and, as such, have found it hard to compete against traditional materials such as EVA. Finally, there is the question of price.

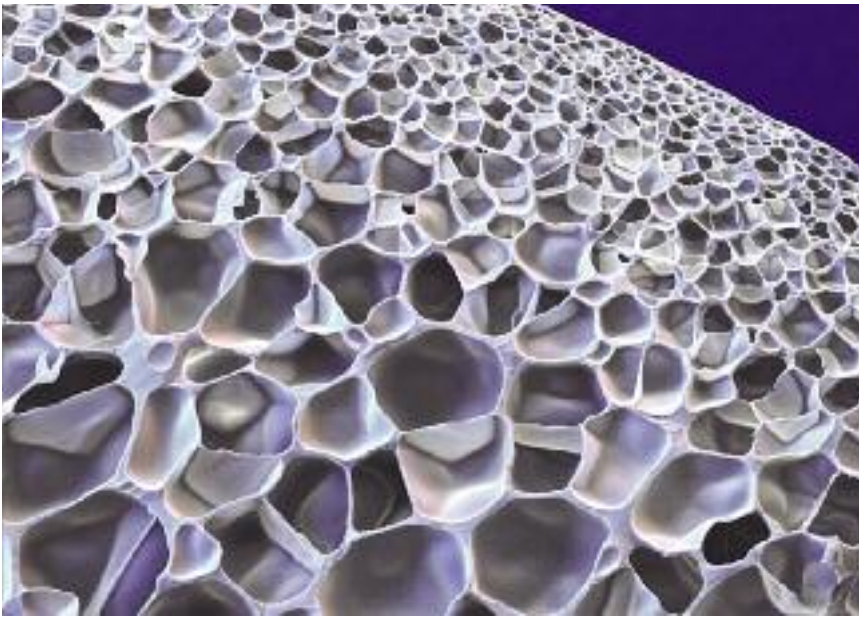
Polyolefins are considerably more expensive than EVA which, while clearly not as good in terms of performance, is, as stated, well established, reliable and, in terms of performance, still considered satisfactory by a majority of sports shoe producers.

ETPU

The second and probably most promising alternative to EVA is eTPU (expanded TPU). TPU is formed by the reaction of diisocyanates with short-chain diols (so-called chain extenders) and diisocyanates with long-chain diols. Varying the structure and/or molecular weight of these three compounds allows the reaction to be fine tuned to produce a wide variety of final properties. eTPU has been developed by BASF and is produced by foaming granules of TPU. Pressure and heat causes them to inflate rather like popcorn, increasing their



CREDIT: ADIDAS



Foam beads with closed gas bubbles give eTPU its ability to bounce back.

CREDIT: BASF SE

volume tenfold and creating foam beads that have small, closed gas bubbles inside. It is these sealed air cells that give eTPU its elastic properties and the more air they contain, the more bounce they have, making the material ideal for midsoles.

The company says the material, which it markets under the name Infinergy, has superior energy cushioning and, due to its closed-cell structure, springs back into shape immediately after impact with the ground. This cushioning triggers an energy-return every time downward force is applied, increasing efficiency and allowing the wearer to expend less energy while running. Resilience tests have shown it to have a rebound height of 55% compared to EVA at 35%.

BASF in fact describes eTPU as 'the most elastic particle foam currently available on the market'. Soles made from it are also said to be more durable as the material is able to maintain its compression set for far longer than EVA. High-frequency fatigue testing supports this having shown it continues to be resilient under continuous load and loses less than 10% of thickness, suggesting it returns nearly all of the energy exerted on it.

AHEAD OF EVA

Gerd Manz, senior innovation director for global brands at adidas, which has worked closely with BASF on the material and uses it in its Boost range of shoes, says that "during testing

the material was compressed 10,000 times to evaluate its resistance. Although the foam is softer than previous materials, the cell structure remained intact for much longer and the shoe retained its properties for hundreds of kilometres".

It also performs well across a range of temperatures. It was tested from -20°C to 40°C and the results showed that the sole underwent less hardening in cold temperatures and less softening when exposed to warmer conditions. This temperature resistance makes it ideal for an all-purpose running shoe. It also absorbs less water, allowing it to function effectively in extreme weather conditions. Over a 24-hour test period, only 2% of water by volume was absorbed, which compares favourably to the recorded performance of EVA.

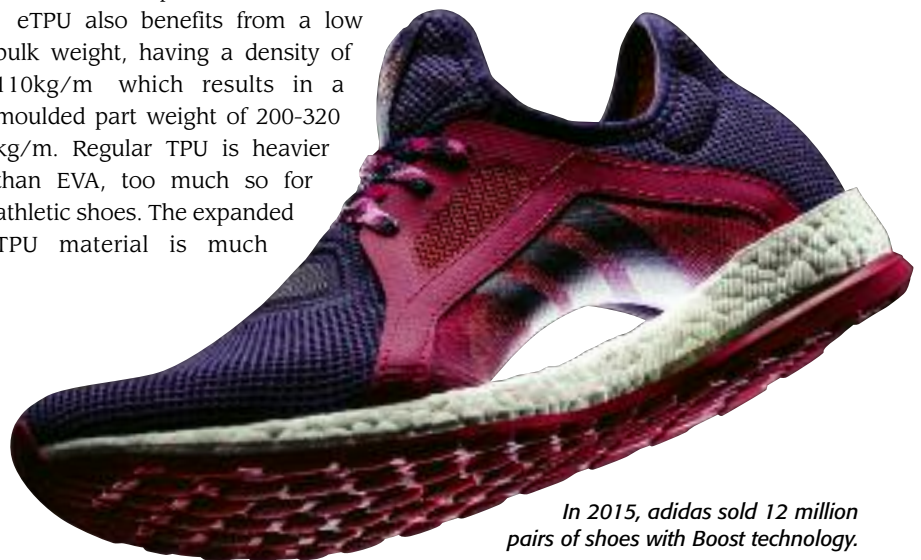
eTPU also benefits from a low bulk weight, having a density of 110kg/m³ which results in a moulded part weight of 200-320 kg/m. Regular TPU is heavier than EVA, too much so for athletic shoes. The expanded TPU material is much

lighter in weight which, when combined with its good flexibility, makes it suitable for use in all kinds of sports shoes. Important characteristics of TPU are nevertheless retained, including high breaking elongation (100%-150% depending on density), high tensile strength (approximately 600 kilopascals) and good abrasion and chemical resistance.

A REPLACEMENT FOR EVA?

We have looked at polyolefins and have seen that while they have pluses compared to EVA, they also have minuses in terms of both processing and cost. eTPU on the other hand scores considerable pluses in regard to both performance and processing. TPU in general is widely acknowledged to be a superb soling material and in this expanded form it would appear to have great potential.

Adidas clearly considers that eTPU could be the way to go as far as midsoles are concerned as witnessed by its use in the company's Boost range. Indeed, chief executive Herbert Hainer has suggested that it can "replace EVA completely". Adidas is however a producer of sports shoes aimed at the top end of the market in terms of performance and as such can afford to be more concerned about performance than pure cost. The vast majority of sports shoe producers, on the other hand, remain price driven, so although eTPU will certainly find a market where performance is the selling point, replacing EVA completely may take a little more time. 🌀



In 2015, adidas sold 12 million pairs of shoes with Boost technology.

CREDIT: ADIDAS