



Magnified image of a water globule on a feather helps illustrate the minute world of nanotechnology. CREDIT: ISTOCK.COM/EDELMAR

Nanofoot project

The 24-month Nanofoot project which began in September 2013 (see *World Footwear* March/April 2015) is now complete. Its purpose has been to pursue the development of advanced and innovative nanotechnology-based solutions for leather and polymer components for footwear products, sustainable and customer-driven production of consumer goods where health, environment, high quality of components, fair marketing communication and retail price are combined to promote a company's competitiveness. The project was a European R&D initiative to develop innovative nanotechnology-based solutions for leather and polymer components for footwear, supported by the European Executive Research Agency (REA).

Extensive research has been carried out over the past 24 months to develop a technological shoe that combines comfort with environmental care by changing the concept of footwear to make it functional, from production to

final disposal, by exploring the potential benefits of nanoparticles (NPs). During the course of the project, new leather and microfibre materials for uppers and linings were created as well as new polymer materials for insoles and soles, and innovative leather footwear and footwear suitable for vegans. Five SMEs and four Research and Technological Development institutions (RTDs) took part as listed in the earlier article.

EUROPE'S PROBLEM

According to APICCAPS, the Portuguese Footwear Association, estimates global production of footwear in 2013 reached 22 billion pairs, with Asia continuing to be the principal source at 87%. Europe and Asia do however specialise in different product segments, with Europe concentrating on high quality, added value products and Asia on mass production and lower priced items.

The European footwear Industry has faced severe competition from countries with lower labour costs and

less regulation, which has forced EU producers to adopt serious restructuring strategies and policies based on high added value production to target middle class consumers. As a result, a large number of SMEs have been forced to reinvent their business models over the past 20 years to become modern companies that need to innovate continuously in order to offer their customers adequate goods and services.

Where footwear was once regarded as a traditional manufacturing sector, it has showed its innovative and development capability by making a heavy investment in R&D to create advanced and high quality products and processes. Nowadays, it uses sophisticated technologies and automated manufacturing processes to produce specialised and high quality products. The quality and specialisation of the footwear now produced also depends on the materials, components and type of construction used in the development of the final product.

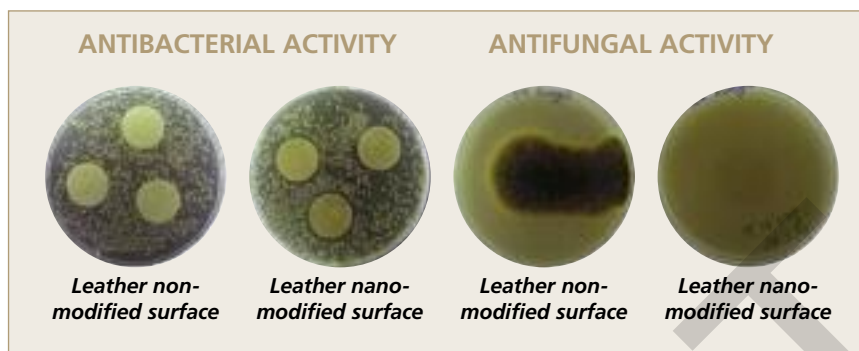
PROCESSING

SMEs are under pressure from rapidly changing demands due to fashion-related and seasonal fluctuations, as well as emerging consumer needs in terms of well-being, health and sustainability. The Nanofoot project explored potentialities and benefits of using NPs such as Ag (silver), ZnO (zinc oxide), Cu (copper) and CuO (copper oxide) that are already available in the market and used in sectors such as aerospace, health, cosmetics and other industries for footwear and associated components. Areas explored included the following which, if successful, will help SME's to remain competitive.

1. Natural leathers and microfibres with antimicrobial and breathability properties.
2. Polymers for footbeds, insoles and outsoles with thermal and electrical conductivity.
3. Processing and coating materials incorporating NPs for natural and artificial leathers.
4. Leather for orthopaedic and comfort/fashion for footwear vegans.
5. Competitive processes for producing workplace and environment friendly materials.
6. Replacing bulk materials with NPs and improving their formulations and manufacture.

To achieve these objectives, the following research activities were selected for the RTDs.

1. Screening, selecting and modifying NPs to solve stability and dispersion limitations.
2. Investigate the application of the selected NPs to develop the results specified.
3. New formulations of functional processing products and coatings based on NPs.
4. Leather and microfibres similar to leather and their manufacturing processes.
5. Polymeric composite materials and components and their manufacturing processes.
6. Develop footwear products that maximise antimicrobial and thermal properties.



Comparative images showing antibacterial and antifungal activity on normal and nano-modified material surfaces. CREDIT: CTCF

IMPROVING FOOTWEAR

Footwear is designed to provide comfort, pleasure and to protect the feet from hard and rough surfaces. In the case of safety footwear, it also offers protection against aggressive and health threatening conditions. Consumers now increasingly search for footwear which promotes their comfort, health and welfare. To remain competitive, manufacturers need to put their efforts into the development of advanced products to meet these changing needs.

At present, despite the vast amount of footwear available in the market and an increase in product quality, there are several properties that need improvement, namely, antibacterial and antifungal properties linked with foot malodours, skin problems, degradation of leather during storage, thermal properties to solve temperature and humidity problems inside the shoe and electrical conductive properties to allow the dissipation of charges.

Furthermore, these properties while not isolated, are interconnected, so it is necessary to find an optimum balance between them. For example, the antibacterial and antifungal properties of footwear are not achieved by merely using antifungal and antibacterial products. The temperature and the humidity of feet and materials also play a major part. Again, the material on its own will not solve the problems so it is necessary to develop footwear to create synergies between all these parameters.

In actual fact, thanks to the fundamental research work done in the last twenty years, the development of nano-functionalised materials for a variety of applications (e.g. health,

automotive, consumer goods, etc.) where mechanical, thermal, electrical, barrier, chemical, antibacterial, antifungal or other functional properties as well as aesthetic properties are required, is pursued worldwide. The use of nanoparticles or nano-sized objects is now being explored because only a small amount may be needed to achieve enhanced or new properties and characteristics.

RESULTS

The following positive results have been obtained by the project.

Microbe resistant leathers and microfibres based on nanoparticles and nanofillers, water resistant leathers and materials usable in shoe uppers, linings and insoles.

Polymers and composites with thermal and electrical management properties based on nanoparticles and nanofillers which suggest that antistatic nanocomposites would improve both comfort and safety as they reduce the accumulation of electrostatic charges.

Thermally comfortable footwear, antistatic and electrical conductive footwear, vegan comfort fashion footwear and leather made orthopaedic footwear would all benefit from the use of NPs in their manufacture.

Replacing bulk materials by NPs and improving nanoparticle-based formulations and their manufacturing procedures can produce environmentally friendly materials and footwear at an acceptable cost.

Although it is still early days as far as full commercialisation is concerned, Nanofoot has clearly established the potential of using NPs in footwear manufacture and it will be interesting to see what the future will bring. 🍷