"The Infinite Potential of Nanofibers: Unveiled through the World's First Mass Production Initiative"

Various outdoor products are made using nanofibers
Photo: Ick Soo KIM

The emergence of mass production technology, once considered daunting, has now unlocked limitless possibilities for ultrafine nanofibers measuring a mere 100 nanometers (nm)[1]. When utilized in the production of masks, these fibers signify a revolutionary material capable of blocking over 99% of pollen and viruses. Their versatility extends across diverse sectors, spanning from medical and food to clothing and even energy industries.

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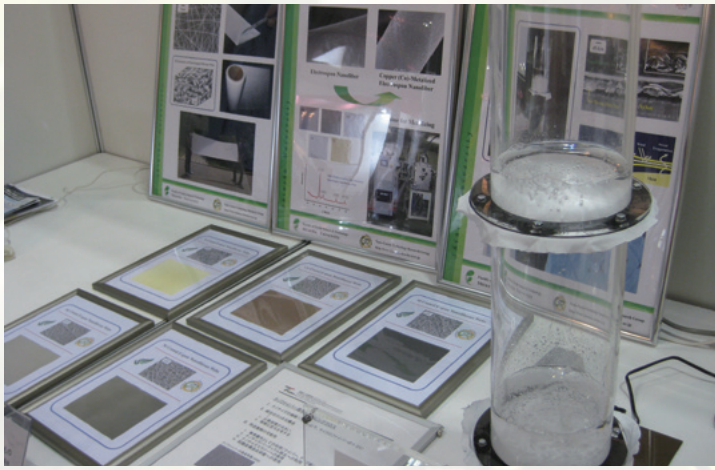
Nanofibers are extraordinarily thin fibers, with a diameter 1/500th that of a human hair. Masks made from these fibers provide exceptional breathability while effectively protecting against moisture, viruses, pollen, PM2.5 particles, and other particles as small as 0.3μm (micrometers)[2], which could potentially harm the human body. These masks boast a filtration efficiency of over 99%.

Under the leadership of Professor Ick Soo KIM, the laboratory at Shinshu University has achieved a remarkable milestone by successfully enabling the mass production of nanofibers, a task long considered difficult. Shinshu University holds a unique position in Japan as the sole institution boasting a Faculty of Textile Science and Technology, with roots tracing back to 1910. During that era, Nagano Prefecture served as a prominent silk-producing region, and Shinshu University originated as the Ueda College of Sericulture, a government-run technical college. However, in 1949, following educational reforms, it transformed into the Shinshu University Faculty of Textile Science and Technology. Throughout its 114-year journey to the present day, the Faculty of Textile Science and Technology has remained steadfast in its commitment to advancing scientific techniques for yarn spinning, fabric weaving, and product refinement.

In 2010, Professor Kim achieved a groundbreaking milestone by successfully developing the world's first mass production plant for nanofibers. He credited the inspiration for this production method to the *shishi-odoshi*[3], a traditional Japanese garden device. Rather than employing nozzles akin to injection needles, this technique involves flowing various polymers[4] through the tip of an angled "needle" while applying a high voltage. This method causes the polymers to stretch under electrostatic forces, leading to the creation of extraordinarily thin fibers. Such an innovative breakthrough has been compared to the invention of rockets during an era dominated by bows and arrows.

A *shishi-odoshi*, which served as the inspiration for the mass production of nanofibers

Photo: PIXTA



Development in progress for the nanofibers for the mass production of nanofibers

Photo: Ick Soo KIM

Nanofiber masks are lighter than a single sheet of A4 paper

Photo: Ick Soo KIM

The inaugural product leveraging nanofibers from this production line was a mask intended to ease the discomfort of hay fever (pollinosis) sufferers. Its effectiveness was demonstrated during the 2011 Tokyo Marathon, where runners reported enhanced breathability. In 2014, following the eruption of Mount Ontake[5], Professor Kim's team supplied nanofiber masks to local elementary schools to protect against volcanic ash. During the COVID-19 pandemic, the laboratory innovated further by producing N95 masks with superior virus-filtering features, donating over 56,000 masks to the Nagano Prefectural Office and the Japanese Nursing Association[6]. Their significant contributions were recognized in 2022 when research group was awarded the Minister of Education, Culture, Sports, Science, and Technology Award for Science and Technology in the Development Category, celebrating the vital role of nanofiber masks in the fight against the COVID-19 pandemic.

The utilization of these highly breathable nanofibers is not limited to medical applications but spans across a variety of sectors, including sports apparel, outdoor equipment, vehicle ventilation systems, and fruit protection bags that improve sugar concentration and pre-harvest risk. With the establishment of a mass production system, Professor Kim's laboratory is now handling an increasing volume of requests for collaborative projects from diverse companies.

Nanofibers are closely aligned with the Sustainable Development Goals (SDGs) thanks to their washable and reusable nature, significantly minimizing product waste. The mass production technology for nanofibers harbors considerable potential to improve our daily lives and stands out as a cutting-edge innovation poised to shape a more promising future.

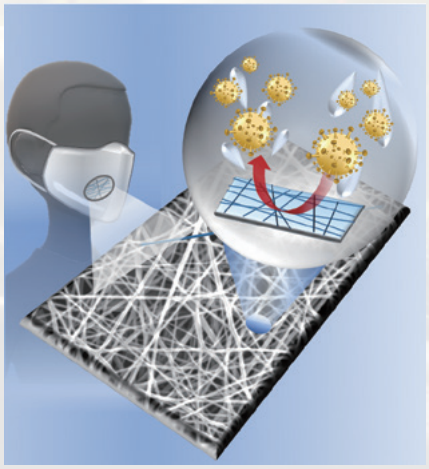


Image of a mask that blocks over 99% of pollen and viruses

Photo: Ick Soo KIM

1.1nm = 10^{-9} meters (m) = one billionth of a meter

2.μm corresponds to one millionth of a meter.

3.The mechanism involves pouring water slowly into a bamboo tube. As the water fills the tube, its weight causes the bamboo tube to tilt and spill the water. When the bamboo tube becomes lighter and returns to its original position, it hits a stone or another object, creating a loud sound or vibration. Originally, it was used to scare away animals such as deer.

4.Molecules with high molecular weight whose scientific structure is essentially a polymer (composed of regular repeating structural units).

5.An active volcano located on the border between Nagano Prefecture and Gifu Prefecture. During the eruption in September 2014, the disaster resulted in 63 deaths and missing persons.

6.The largest professional nursing organization in Japan, operated by individuals with nursing qualifications who voluntarily join.