

Centrifugal multispun nanofibers put a new spin on COVID-19 masks

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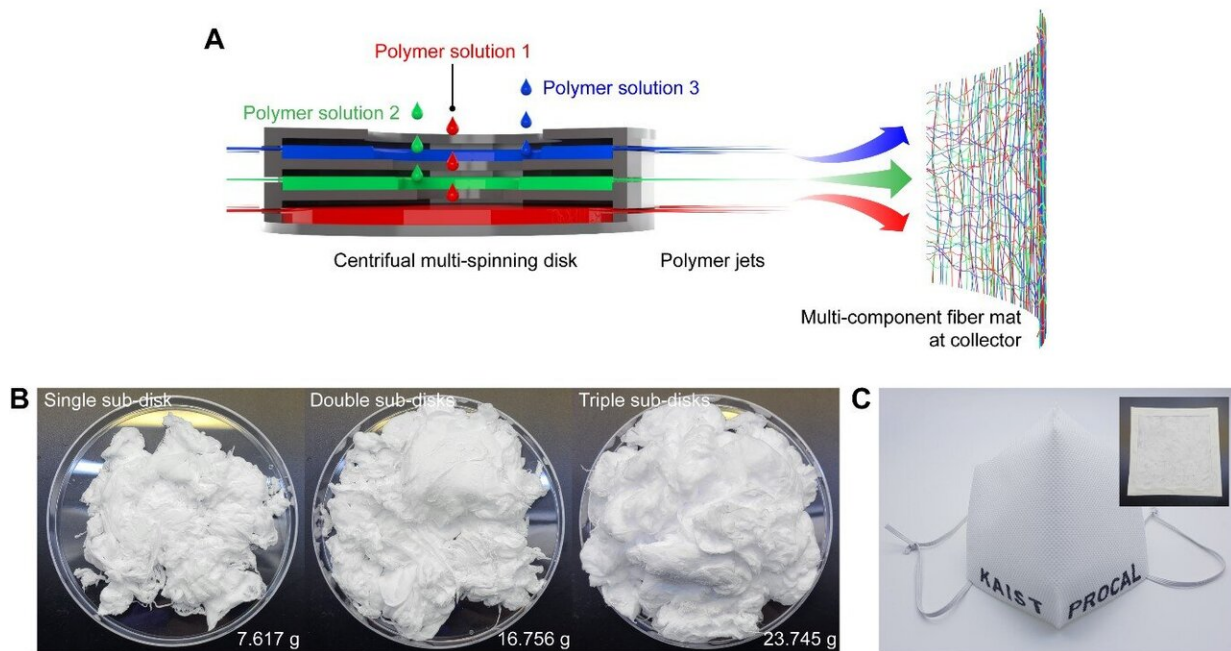


Figure. (A) Schematic illustration of the centrifugal multispinning polymer nanofiber production process. (B) The polymer nanofibers spun by the system. The increase of the number of sub-disk shows the proportional enhancement of the productivity. (C) Face masks and mask filters fabricated using mass-produced nanofibers (inset). Credit: The Korea Advanced Institute of Science and Technology (KAIST)

KAIST researchers have developed a novel nanofiber production technique called 'centrifugal multispinning' that will open the door for the safe and cost-effective mass production of high-performance polymer nanofibers. This new technique, which has shown up to a 300 times higher nanofiber production rate per hour than that of the conventional electrospinning method, has many potential applications including the development of face mask filters for coronavirus protection.

Nanofibers make good face mask filters because their mechanical interactions with aerosol particles give them a greater ability to capture more than 90% of harmful particles such as fine dust and virus-containing droplets.

The impact of the COVID-19 pandemic has further accelerated the growing demand in recent years for a better kind of face mask. A [polymer](#) nanofiber-based mask filter that can more effectively block harmful particles has also been in higher demand as the pandemic continues.

"Electrospinning' has been a common process used to prepare fine and uniform polymer nanofibers, but in terms of safety, [cost-effectiveness](#), and [mass production](#), it has several drawbacks. The electrospinning method requires a high-voltage electric field and electrically conductive target, and this hinders the safe and cost-effective mass production of polymer nanofibers.

In response to this shortcoming, 'centrifugal spinning' that utilizes [centrifugal force](#) instead of high voltage to produce polymer nanofibers has been suggested as a safer and more cost-effective alternative to the electrospinning. Easy scalability is another advantage, as this technology only requires a rotating spinneret and a collector.

However, since the existing centrifugal force-based spinning technology employs only a single rotating spinneret, productivity is limited and not much higher than that of some advanced electrospinning technologies such as 'multi-nozzle electrospinning' and 'nozzleless electrospinning.' This problem persists even when the size of the spinneret is increased.

Inspired by these limitations, a research team led by Professor Do Hyun Kim from the Department of Chemical and Biomolecular Engineering at KAIST developed a centrifugal multispinning spinneret with mass-productibility, by sectioning a rotating spinneret into three sub-disks. This study was published as a front cover article of *ACS Macro Letters*, Volume 10, Issue 3 in March 2021.

Using this new centrifugal multispinning spinneret with three sub-disks, the lead author of the paper Ph.D. candidate Byeong Eun Kwak and his fellow researchers Hyo Jeong Yoo and Eungjun Lee demonstrated the gram-scale production of various polymer nanofibers with a maximum production rate of up to 25 grams per hour, which is approximately 300 times higher than that of the conventional electrospinning system. The production rate of up to 25 grams of polymer nanofibers per hour corresponds to the production rate of about 30 face mask filters per day in a lab-scale manufacturing system.

By integrating the mass-produced polymer nanofibers into the form of a mask filter, the researchers were able to fabricate face masks that have comparable filtration performance with the KF80 and KF94 face masks that are currently available in the Korean market. The KF80 and KF94 [masks](#) have been approved by the Ministry of Food and Drug Safety of Korea to filter out at least 80% and 94% of harmful particles respectively.

"When our system is scaled up from the lab scale to an industrial scale, the large-scale production of centrifugal multispun polymer nanofibers

will be made possible, and the cost of polymer [nanofiber](#)-based face mask filters will also be lowered dramatically," Kwak explained.

More information: Byeong Eun Kwak et al. Large-Scale Centrifugal Multispinning Production of Polymer Micro- and Nanofibers for Mask Filter Application with a Potential of Cospinning Mixed Multicomponent Fibers, *ACS Macro Letters* (2021). [DOI: 10.1021/acsmacrolett.0c00829](#)

Provided by The Korea Advanced Institute of Science and Technology (KAIST)

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