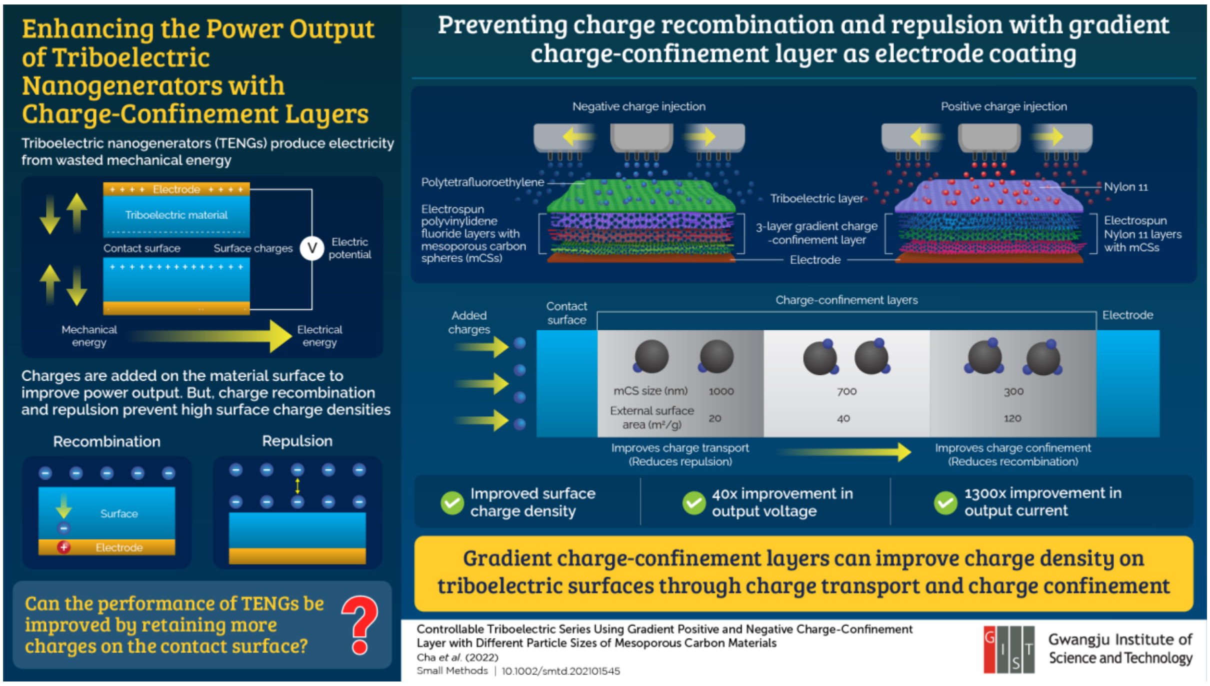
PRESS RELEASE

Gwangju Institute of Science and Technology Scientists Improve the Power Output of Triboelectric Nanogenerators with Carbon Particles

Mesoporous carbon spheres facilitate charge transport and high surface charge densities in triboelectric nanogenerators for a 1300-fold higher output current

When two dissimilar materials are brought in contact and separated, electricity is produced via charge separation at the surface. Using this concept and electrostatic induction, triboelectric nanogenerators (TENGs) convert mechanical energy into electrical energy. However, TENGs suffer from low power output owing to low surface charge densities. Now, GIST researchers have realized a charge confinement layer with mesoporous carbon that enables high surface charge densities in TENG materials, improving their power output and commercialization potential.



Most of us have felt the shock from static electricity by touching a metallic object after putting on a sweater or walking across a carpet. This occurs as a result of charge build-up whenever two dissimilar materials (such as our body and the fabric) come in contact with each other.

In 2012, scientists from the USA and China used this phenomenon, known as "triboelectric effect," to build a triboelectric nanogenerator (TENG) that converts unused mechanical energy into useful electrical energy. Their device consisted of two triboelectric polymer films with metallic electrodes, which, when brought together and separated, resulted in charge separation and the development of an electric voltage sufficient to power small electronic devices.

Viewed as potential sustainable energy harvesters, efforts have been made to enhance the power output of TENGs by injecting charges to the surface of triboelectric films. However, charge recombination in the electrode and charge repulsion on the surface of the material prevents them from achieving high surface charge densities.

Against this backdrop, a team of researchers led by Professor Chanho Pak from the Gwangju Institute of Science and Technology (GIST) in South Korea developed, in a recent study, a charge-confinement layer that manages the transfer of injected charges between the triboelectric film and the electrode to improve the charge density on the surface of the triboelectric film. This paper was made available online on 16 March 2022 and was published in Volume 6 Issue 5 of *Small Methods* on 18 May 2022.

"*In the design of high-performance TENGs, it is critical to transport the charge on the surface to a deep position while reducing charge recombination*," says Prof. Pak. To make the layers, the researchers used electrospun mesoporous carbon spheres together with layers of polyvinylidene fluoride (PVDF) and nylon. The carbon spheres, which trap charges on the surface, were arranged in ascending order of their specific surface areas, making for a gradient charge-confinement layer. As a result of this gradient arrangement, the injected charges could drift towards the electrode but were confined just before reaching it. "*The layers transport as well as confine the charges*," explains Prof. Pak.

By transporting the charges away from the surface, the layers prevent injected charges from accumulating and repelling each other on the surface of the triboelectric material, allowing it to hold more charge. Additionally, confining the charges close to the electrodes prevents charge loss due to recombination, resulting in a triboelectric surface with a higher charge density.

With the addition of charge-confining layers, the researchers improved the output voltage and current of the TENG by 40 and seven times, respectively. Additionally, by combining a cylindrical TENG and an electromagnetic generator, they achieved a dramatic 1300-fold enhancement in output current.

"*With these promising results, TENGs could one day be powerful enough to serve as sustainable energy harvesters as well as power wearable devices of the future,*" says Prof. Pak.

And we can't wait to find out!

Reference

Authors:	Seokjun Cha[1], Yujang Cho[1,2], Jong Gyeong Kim[3], Hyeongsub Choi[1], Dahye Ahn[1], Jingzhe Sun[1], Dong-soo Kang[1], Chanho Pak[3,*] and Jong-Jin Park[1,*]
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Affiliations: [1] Chonnam National University, Republic of Korea
[2] Korea Advanced Institute of Science and Technology (KAIST), Republic of Korea
[3] Gwangju Institute of Science and Technology, Republic of Korea

*Corresponding authors 'emails:

Jong-Jin Park: jjpark@jnu.ac.kr

Chanho Pak: chanho.pak@gist.ac.kr

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The Gwangju Institute of Science and Technology (GIST) is a research-oriented university situated in Gwangju, South Korea. Founded in 1993, GIST has become one of the most prestigious schools in South Korea. The university aims to create a strong research environment to spur advancements in science and technology and to promote collaboration between international and domestic research programs. With its motto of "A Proud Creator of Future Science and Technology," GIST has consistently received one of the highest university rankings in Korea.

Website: http://www.gist.ac.kr/

About the authors
Chanho Pak is a professor at the Graduate School of Energy Convergence at Gwangju Institute of Science and Technology (GIST) in Korea. Before joining GIST, he worked at Samsung Advanced Institute of Technology and Samsung SDI, where he researched catalysts and fuel cells. He also did a post-doctoral stint at Yale University and the University of California, Berkeley in USA. His group at GIST is developing materials and devices for energy storage and conversion including capacitors, fuel cells, and water electrolysers.

Jong-Jin Park is a professor at the Department of Polymer Science & Engineering at Chonnam National University in Korea. Before coming to Chonnam National University, he worked at Samsung Advanced Institute of Technology, researching OLED devices. He obtained his Ph.D. at the Korea Advanced Institute of Science and Technology. His group is researching on functional polymer nanomaterial synthesis, textile-based wearable devices, and energy harvesting devices, including triboelectric and piezoelectric generators.