# [Interview H] Professor Nam-Joon Cho of Nanyang Technological University, Singapore: "A Single Grain of Pollen Can Change an Industrial Paradigm"

Reporter Lee Jae-hyung Posted 2025.09.09 15:43Comments 0

> A successful case study of the "Transformation Economy"—transforming discarded resources into sustainable solutions—presents a solution to fundamental problems with pollen, including its potential to cause allergies and difficulties in processing.
> "It is important to ensure that laboratory results create a tangible impact through commercialization."

Professor Nam-Joon Cho, founder of the bio venture Luca AI Cell, a distinguished professor in the Department of Materials Science and Engineering Nanyang Technological University (NTU) in Singapore, and a pioneering scholar in the fields of materials science and infectious disease medicine, exploring new paths for the sustainability of humanity from 'discarded materials.'

His research team is attracting worldwide attention for developing an innovative biomaterial that can replace plastic and save coral reefs by utilizing the sturdy outer wall of pollen, which is often considered an allergy-causing "seasonal intruder."

This magazine met with Professor Nam June Cho in person and conducted an in-depth conversation to discuss his academic journey, the current state pollen-based technology, and his vision for solving the environmental problems facing humanity.

Your research activities span the fields of materials engineering, chemical engineering, and medicine. How has this interdisciplinary journey influenced your research on pollen-based biomaterials?

Nam June Cho, Professor of Materials Science and Engineering at Nanyang Technological University (NTU), Singapore.

Materials engineering knowledge has enabled us to understand the fundamental properties and structure of the natural material known as the pollen coa Chemical engineering has become an essential foundation for scaling up small reactions discovered in the laboratory into efficient and safe mass productio processes.

My experience at Stanford University School of Medicine opened my eyes to seeing pollen not simply as an industrial material, but as an innovative mater for healthcare and pharmaceuticals that can be directly applied to the human body. Interdisciplinary integration is also at the core of my research philosoph "Cross Economy." Cross Economy is a paradigm that transforms unused byproducts, including waste, into new industrial opportunities through mater innovation.

Pollen plays a vital role in nature and is abundant, yet most of it is discarded or considered an unwelcome guest that triggers allergies. My research preser a successful example of a transformational economy that transforms this "waste resource" into a sustainable solution.

My academic journey wasn't a chance crossing of multiple fields, but rather a process of ultimately finding convergent solutions that could simultaneously address both human and environmental issues.

### How was pollen transformed into a plastic substitute? What is the core technology, "pollen microgel," and how is it made?


The outermost layer of pollen is composed of sporopollenin, one of the strongest biopolymers in nature. [Photo = Getty Images Bank]

Pollen possesses a unique and robust structure, earning it the nickname "the diamond of plants." Pollen's outermost layer (exine) is composed sporopollenin, one of the hardest biopolymers in nature. This hardness has previously made processing it extremely difficult.

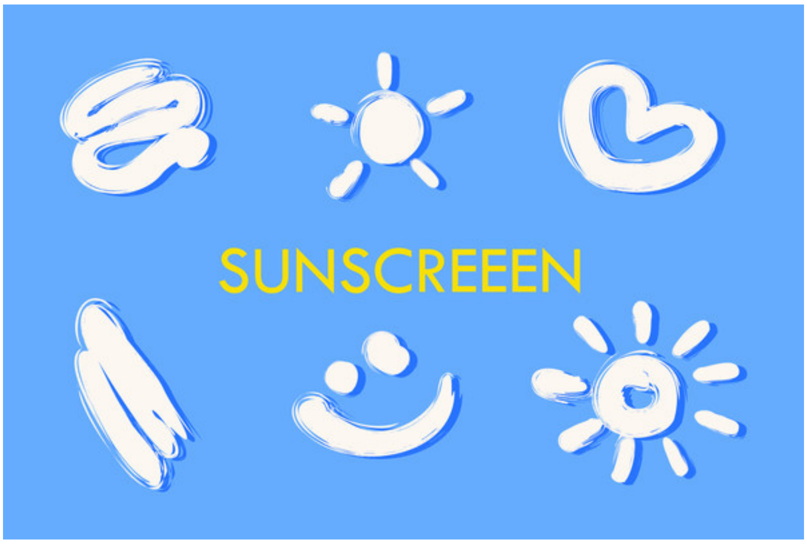
The core of our research is overcoming this limitation of "stiffness" through a chemical process. The process of making pollen microgels is largely divide into two steps.

First, the pollen undergoes a "defatting" process, removing lipids and allergenic proteins attached to the outer surface of the pollen using an organic solve (acetone). Since the proteins, the primary cause of allergies, are found within the pollen's interior (protoplast), this pretreatment process ensures safety.

Next, the defatted pollen is placed in an alkaline aqueous solution and treated twice. The first step involves a brief reaction at 80 degrees Celsius for 2 to hours, altering the surface chemical structure of the outer wall. This process allows the pollen particles to easily absorb water.

Afterwards, through a 'hydrolytic degradation' process of cultivating for a short time at a relatively low temperature of 15 to 25 degrees Celsius, the ha pollen particles are transformed into microgels that are flexible and easy to process, like jam.

The value of this technology lies not simply in the discovery of a new material. By simultaneously addressing two fundamental issues with pollen— potential for allergy and its processing difficulties—through a chemical process, it transforms a "discarded byproduct" abundant in nature into a high-valu raw material.




Professor Cho's research team attracted attention with research results showing that a sunscreen made from camellia pollen lowers skin temperature and is harmless to marine ecosystems. [Photo = Getty Images Bank]

Coral reefs serve as the lungs of the marine ecosystem. However, when chemicals like oxybenzone (BP-3) and benzophenone-2 (BP-2), commonly used in commercial sunscreens, enter the ocean, they damage coral reef genes and cause bleaching, causing devastating damage.

This is a serious problem, considering that approximately 6,000 to 14,000 tons of sunscreen end up in the ocean every year. Our pollen-based sunscre fundamentally solves this problem. In our experiments, corals exposed to commercial sunscreens died from coral bleaching in just two days, while thos using the pollen sunscreen remained healthy for 60 days.

Not only does it offer SPF 30 (blocking 97% of UV rays) performance equivalent to existing products, but thanks to pollen's natural ability to absorb le energy in the visible to near-infrared spectrum, it also provides a cooling effect, lowering skin temperature by approximately 5-9°C. This cooling effect allow us to secure market competitiveness as a "functional product" that directly benefits consumers' skin.

## Are there any other areas where pollen microgels can be used besides sunscreen?

The key properties of pollen microgels are their flexibility, water reactivity, and the ability to freely control their hydrophilicity and hydrophobicity. The properties allow them to be applied in a variety of fields. Let me share a few representative examples.

The first is an oil-absorbing sponge. This hydrophobic sponge, made from sunflower pollen, has the potential to address water pollution issues such a marine oil spills. This sponge has excellent oil-absorbing properties and has been shown to have an absorption capacity comparable to that of commerc oil-absorbing agents.

The second is 3D printing bioink. Existing hydrogel-based bioinks have the limitation of maintaining their shape after printing. By mixing in pollen microge the printed product maintains a robust structure, making it ideal for use as a 3D printing material in biomedical applications such as "scaffolds" for tissu regeneration, wound dressing patches, or face masks.

The final component is a drug delivery system. Sporopollenin, the outer membrane of pollen, maintains its shape stably even in the acidic environment of th stomach and has surface properties that allow it to adhere well to the mucosa. This makes it ideal for use as a drug delivery system, loading the polle membrane with drugs and slowly releasing them to the desired target. It is particularly effective in delivering high-molecular-weight drugs, such as protei and nucleic acids, that are difficult to absorb in the body with existing systems.

## How do you plan to overcome the current batch process to enable mass production?

The pollen microgel manufacturing process currently being conducted in our laboratory is batch-based, which presents clear limitations in terms production volume and efficiency. The solution to this problem is continuous flow reactor technology.

A continuous reactor is a process that continuously produces the final product by continuously adding small amounts of reactants to a tube or microreact exothermic reactions can be controlled much more safely. Second, by precisely controlling key variables such as reaction time, temperature, and pressur product quality and yield can be dramatically improved.

The problem is that while this series of processes is feasible on a laboratory scale, transitioning to mass production requires advanced, dedicate equipment. Conventional extractors and chemical processing equipment alone struggle to ensure consistent quality, and their processing capacity is limite Therefore, automation modules capable of simultaneously processing large quantities of pollen while precisely controlling reaction conditions are required.

We have already filed a patent application for this technology through NTUitive, Nanyang Technological University's startup incubation team, and a currently working with Luca AI Cell to design and develop specialized equipment for processing pollen raw materials to mass-produce and commercializ this technology.

## New materials must overcome numerous regulatory hurdles before they can be commercialized as cosmetics or pharmaceuticals. What hurdles must pollen-based materials overcome?

In Korea, new ingredients must undergo safety reviews and notification procedures by the Ministry of Food and Drug Safety (MFDS) before they can b used in cosmetics. The European Union (EU) is also strengthening regulations on carcinogenic, mutagenic, and toxic for reproduction (CMR) substance The EU has also announced plans to establish a roadmap to ban animal testing by 2026. This signifies the growing importance of materials that a environmentally and human-safe and have not been tested on animals.

The process we developed removes the internal proteins that trigger pollen allergies. This is not just a technical achievement; it's crucial for passing safe assessments by regulatory authorities and gaining consumer trust. Proving our environmentally friendly and ethical production methods will be essential f commercialization.

## I am curious about the ultimate goal and future vision this research envisions.

I hope this research goes beyond simply creating a single product. We often dismiss nature's abundant gifts, like pollen, as "waste" and neglect their use du to a lack of knowledge. Pollen-based technology is a successful example of a "transformative economy" model that transforms the abundant "was materials" found in nature into solutions to environmental problems facing humanity, such as microplastics and ocean pollution.

Our ultimate goal is to develop "sustainable, real-world solutions that positively impact both humanity and the planet." It's crucial that our lab's findings do end in academic papers; they create real-world impact through commercialization.

This will serve as an example of how scientists can contribute to solving societal problems. I believe that a single grain of pollen can shift the paradigm o massive industry and open a new path for humanity to coexist with the Earth.