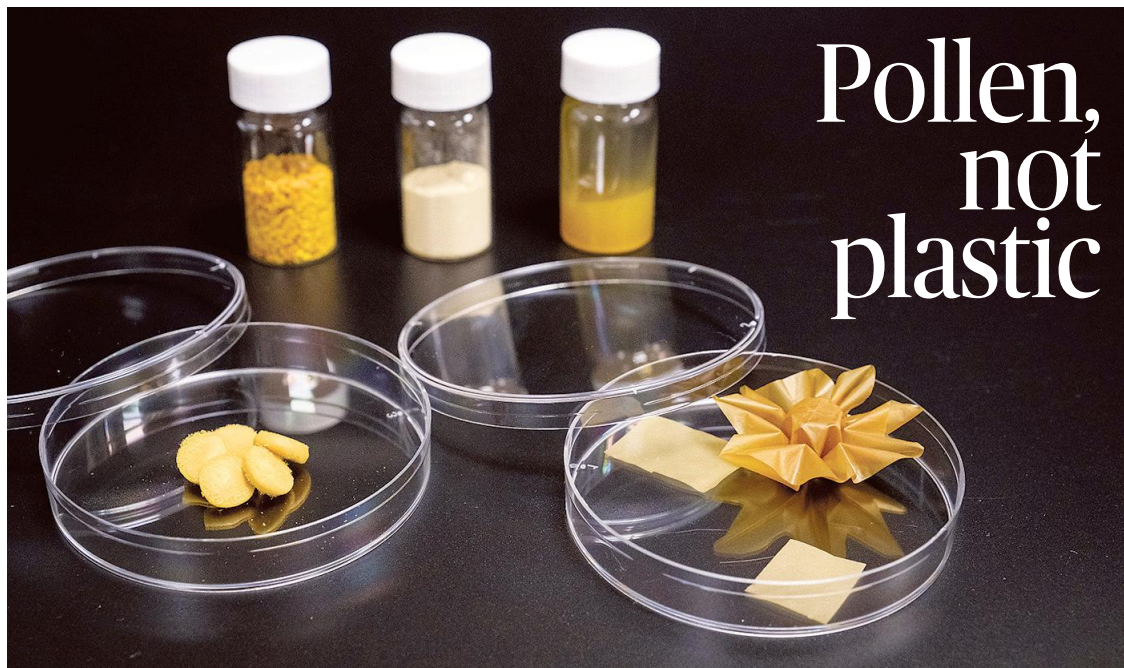


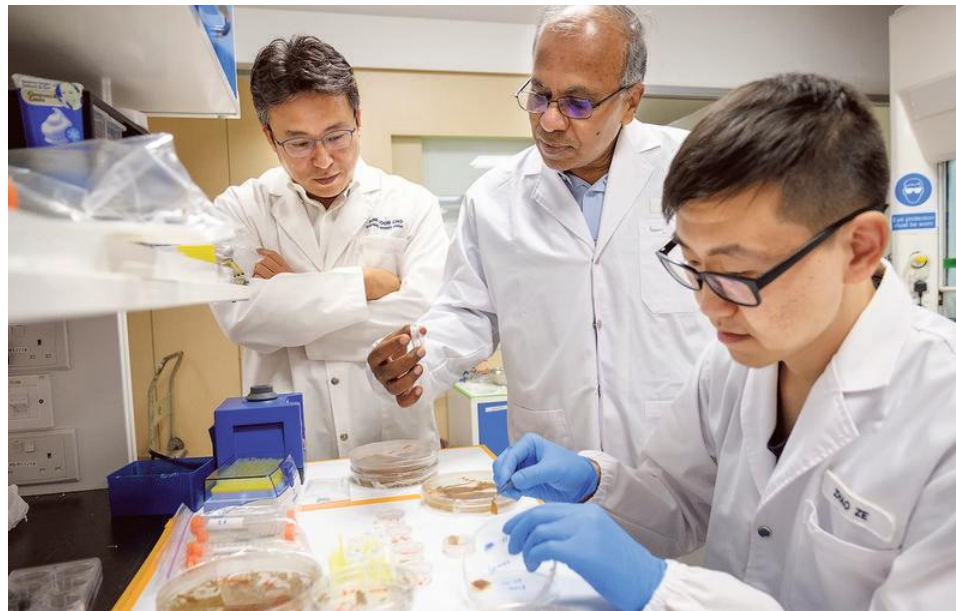


Pollen, not plastic

■ SUNALINI MATHEW

Pollen – Nature’s springtime offering that helps the Earth but is a nightmare for the allergy-prone – may have a whole new purpose. Researchers at the Nanyang Technological University (NTU), Singapore, have created a material out of the pollen from sunflowers. Its USP? It can bend and unbend depending on the moisture in the air, because of structural differences between the top and bottom layer – the former is significantly rougher than the latter. The scientists used the sticky oil-based cement layer that coats the grain’s surface for the material. This was then incubated in alkaline conditions for about 12 hours, making the particles swell and become gel-like. The “soft microgel particles” as they describe it, are then cast into a mould and left to dry.

To show its various applications, the team created a flower that opens when exposed to water vapour. In NTU, they also demonstrated that the paper could ‘walk’ by adjusting the material’s physical properties. The findings were published in the *Proceedings of the National Academy of Sciences of the United States of America* last month.



Sheeted success The team at NTU, Singapore, examining the paper-like material derived from pollen grains ■ SPECIAL ARRANGEMENT

Professor Subra Suresh, NTU President, and one of the authors of the research paper, tells us a little more about the pollen-based paper-like material that could be a substitute for plastic. “Polylactic acid (PLA), which makes plastics, costs about US\$3 per kilogram, while pollen costs only \$0.01,” he says.

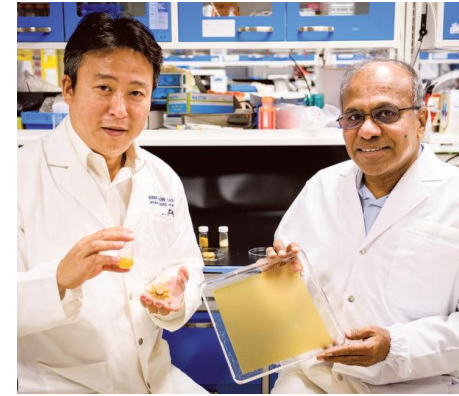
Where did the idea of pollen for material originate?

● The NTU team started this research to translate materials from Nature into materials of use to humans with minimal processing and change. When you think of pollen, the first thing that comes to mind are the allergies that these grains can cause. But the material properties of the pollen, considered to be the diamond of the plant kingdom because of its tough shell, are too good to be overlooked. We were inspired

by the change in the pollen shell’s material properties during biological mechanisms such as germination, and from there, found a way to transform these hard pollen grains into pliable microgel particles. When left to dry, these microgel particles form a paper-like material that bends and curls in response to changing levels of environmental humidity.

What industries can you

Scientists are using technology to turn one of Nature’s toughest ingredients into a biodegradable material that bends and unbends depending on humidity



see this being used in, besides robotics?

● Using strategies that are somewhat analogous to traditional soap-making, the soft microgel particles derived from pollen, could one day serve as a ‘building block’ for the design of new categories of eco-friendly materials. The pollen-like paper is the first such example. The pollen-based microgel particles’ biocompatibility – meaning it does not cause an immunological, allergic or toxic reaction when exposed to body tissues – also makes it potentially suitable for applications such as wound dressing, prosthetics, and implantable electronics. Combined with the power of 3D/4D printing, the pollen-based material could one day be turned into a range of different forms, including polymer gels and sponges, or even replace non-natural plastics.

Why are bio-inspired sensors in focus today?

● Nature sees some of the most extraordinary sensing systems that surpass the capabilities, sensitivity and reliability of commercially available sensors. Understanding the physical, chemical, and biological processes behind natural sensing capabilities will

help us replicate (mimic) or rebuild their systems and functions in human-made devices.

Where does your research take you now?

● The next step is to develop various pollen-based paper actuators by implementing new structural designs or mixing-and-matching different pollen samples. For instance, one of our projects is to fabricate a programmable pollen actuator by integrating a patterned hydrophobic ink on the surface of a pollen paper through fast and facile laser printing. These patterned pollen papers show various conformations depending on patterns under controlled humidity. Our continuum models can successfully predict those structural conformation of pollen papers depending on patterned structures. By integrating materials science and additive manufacturing strategies or 3D printing technology, we could develop sustainable pollen-derived materials that are designed to address the latest industry needs.

If this becomes popular, do you see whole fields of sunflowers being cultivated for this purpose – much like palm for palm oil?

● We already have enough farms or forests around the globe to collect abundant pollen or spores. For example, there are a great number of sunflower farms to produce sunflower seeds or oil. Pollen grains are critical delivery vehicles for transferring plant genetic material as part of plant reproduction.

To ensure reproductive success, plants produce enormous quantities of pollen – most of which ends up as ‘waste’ – and is very cheap to obtain in large quantities. Therefore, our objective is to effectively collect and use these wasted pollen particles, reducing the need to specially cultivate plants just for this purpose. In addition, as mentioned above, aside from sunflowers, there are other plants that produce useful pollen.