The potential of pollen paper

Researchers create a material that responds to humidity.

A comparison of a Van Gogh reproduction printed on pollen paper and regular paper.
NAM-JOON CHO

By Nick Carne

Scientists in Singapore have created a paper-like material derived from pollen that bends and curls in response to changing levels of environmental humidity.

They demonstrated its properties by folding it into a flower that “blooms” in the presence of water vapour – but believe its potential is much greater.

When combined with digital printing, its ability to alter its mechanical characteristics in response to external stimuli holds promise, they suggest, for the fabrication of programmable natural actuators – components in a machine that are responsible for moving and controlling a mechanism.

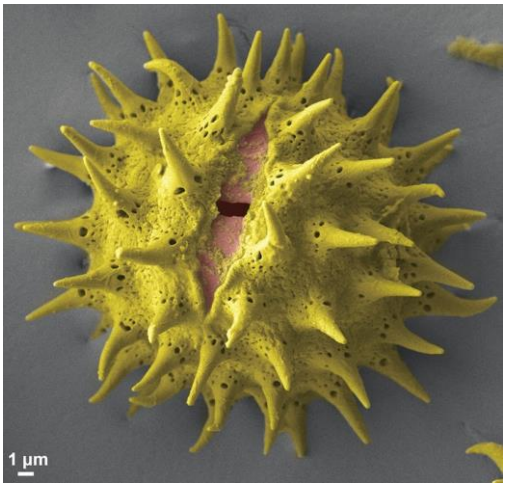
Smart actuators are used in everything from soft robots to energy generators and sensors.

The work by a team from Nanyang Technological University is reported in the journal *Proceedings of the National Academy of Sciences*.

"Much progress has been made in developing bioinspired sensors and actuators based on engineered synthetic materials, but these materials come with limitations, such as issues with environmental sustainability and relatively high cost," says co-author Subra Suresh.

"There remains a critical need to incorporate cost-effective and eco-friendly materials."

NTU researchers have previously reported the ability to convert hard pollen grains into soft microgel particles that alter their properties in response to external stimuli.



Source material: a sunflower pollen grain in close up.
NAM-JOON CHO.

To create their paper, Suresh and colleagues turned pollen grains from sunflowers into a pliable, gel-like material through a process they say is similar to conventional soap-making, but which included incubating the pollen in alkaline conditions for hours.

The gel was then cast into a mould and left to dry, forming the new material.

Scanning electron microscopy revealed that it comprises alternating layers of pollen particles, with the top layer significantly rougher than the bottom one.

The top surface, which appears frosted to the naked eye, shows remnants of the pollen grains' distinct spikes, contributing to its roughness. The bottom has a mirror-like finish and is thus smoother.

The researchers say it is because of this structural difference that the paper starts to bend in humidity then unbend in the dry. Just holding it in your hand can start a response.

And that response can be customised by adjusting processing parameters, chiefly the alkaline incubation time.

In their paper, the researchers describe joining two samples prepared with very different incubation times to form a single strip with a visible boundary.

When this was exposed to a humid-dry cycle, the different reactions from the samples caused the paper to "walk" like a caterpillar – expanding then contracting its soft body.

As a bonus, the processing makes the pollen non-allergenic.