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Pollen-based ‘paper’ holds promise for new generation of natural components

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Scientists at Singapore’s Nanyang Technological University (NTU Singapore) have created a paper-like material derived from pollen that bends and curls in response to changing levels of environmental humidity.

The ability of this paper made from pollen to alter its mechanical characteristics in response to external stimuli may make it useful in a wide range of applications, including soft robots, sensors, artificial muscles, and electric generators.

Combined with digital printing, pollen paper may hold promise for the fabrication of a new generation of programmable natural actuators – components in a machine that are responsible for moving and controlling a mechanism.

The findings, published in the Proceedings of the National Academy of Sciences of the United States of America last week, show how the NTU Singapore team formulated the paper using softened pollen grains.

They demonstrated the pollen-based paper’s properties by folding it into a flower that ‘blooms’ in the presence of water vapour. They also showed that the pollen material’s physical properties can be adjusted, with a strip of pollen-based paper that is able to ‘walk’.

The corresponding authors of this paper are Assistant Professor Song Juha of the School of Chemical and Biomedical Engineering, and Professor Cho Nam-Joon and Professor Subra Suresh of the School of Materials Science and Engineering at NTU.

NTU Distinguished University Professor Subra Suresh, who is also the NTU President, said: “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. There remains a critical need to incorporate cost-effective and eco-friendly materials. Just as pine cones open and close their scales depending on the amount of moisture in the air, our NTU research team has shown that pollen paper created from naturally abundant pollen grains responds as an actuator to changes in environmental humidity.”

NTU Professor Cho Nam-Joon, who holds the Materials Research Society of Singapore Chair in Materials Science and Engineering, said: “These findings build on the recent work by our NTU team, in which we showed how hard pollen grains can be converted into soft microgel particles that alter their properties in response to external stimuli. This process also renders pollen and the products we create from it, non-allergenic.”