Northumbria University NEWCASTLE

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Fold to Glitter – researchers discover novel optical sensing technology

Scientists from Northumbria University have developed a new optical sensing technology which can light up areas of an object or material by creating microscopic wrinkles and folds within its surface.

Inspired by the way the outer layer of plants and animals can change colour in nature, the researchers have combined their expertise in physics and chemistry to create the new technology.

It could have a variety of practical applications, including within flexible wearable devices, electronics, and in 3D printing.

Their research paper setting out the findings, entitled A flexible topo-optical sensing technology with ultra-high contrast, has been published in the prestigious scientific journal *Nature Communications*.

There are two specific elements to the research. The first was the creation of a thin 'film' or material which, when stimulated with a mechanical or electronic signal, results in microscopic folds being created on its surface, usually too small to be seen with the naked eye.

The second element was the creation of a chemical 'paint' which is applied to the material. When the folds are created in the surface, the resulting change in oxygen levels within the 'paint' leads to a chemical reaction. This creates a luminescent effect, making the surface of the material appear to 'light up' in the area where the fold has occurred (see diagram below).

The research was carried out by Dr Ben Bin Xu and Dr Yifan Li, from Northumbria University's Department of Mechanical and Construction Engineering, and Dr Valery Kozhevnikov from Northumbria's Department of Applied Sciences.

Dr Xu, an associate professor in Mechanical Engineering, led the project and said: "Wrinkles and folds are usually unwanted in engineering terms. Similarly, an oxygen quenching effect is not popular in fluorescence science.

"However, through micro-engineering, magic happened, and two unwanted phenomena were turned into a responsive and programmable 'fold to glitter' function."

When subjected to mechanical stimuli, elastomeric materials such as that created by the Northumbria University researchers can undergo surface changes, such as wrinkles and cracks. This can be used to create switchable optical features and structural colour with dynamic luminescent patterns.

The phenomenon of elastic wrinkling and folding exists widely in nature and there has been much research by academics to understand the mathematical and physical science behind these changes and to explore how this could be used for innovative engineering solutions.

It is hoped this latest research will create new opportunities for designing the next generation of flexible/wearable devices.

Professor John Woodward, Pro Vice-Chancellor of Northumbria University's Faculty of Engineering and Environment, said: "This is exciting new research with a number of emerging applications in flexible and wearable electronics and bio-devices."

The work at Northumbria is part of a wider international collaborative research programme which also involved Prof Jie Kong from Northwestern Polytechnical University in China and Prof Ben Zhong Tang from Hong Kong University of Science and Technology.

It has been supported by the Engineering and Physical Sciences Research Council (EPSRC) and the Royal Society Kan Tong Po International Fellowship 2019.

Professor Laurent Dala, head of Northumbria's Department of Mechanical and Construction Engineering, added: "The outcomes show promise for future international collaboration between Northumbria University, Northwestern Polytechnic University, China and Hong Kong University of Science and Technology and indicate the benefit of UKRI finding International research teams through fellowship grants."

Find out more about Northumbria University's Department of Mechanical and Construction Engineering and Engineering Materials and Mechanics Group (EM^{2}G).

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