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Singapore researchers develop novel material to tackle water pollution and wastewater management

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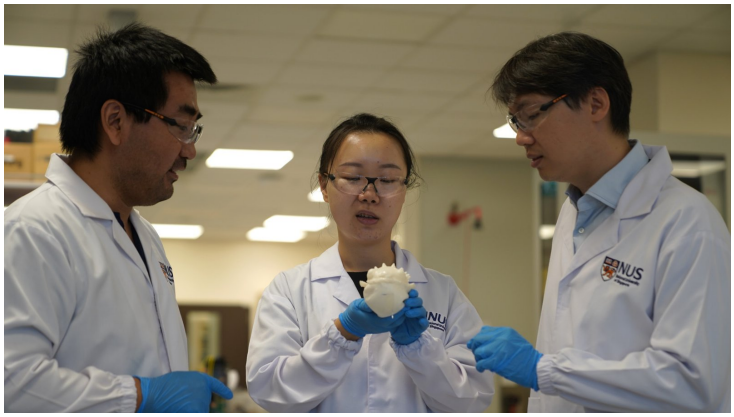
Develops ReSURF as a sustainable solution for real-time, on-site, and sustainable water quality monitoring



Develops ReSURF as a sustainable solution for real-time, on-site, and sustainable water quality monitoring

As a vital component of human health and well-being, clean, safe water contributes to food security, supports high-tech industries, and fosters sustainable urbanization. The ability to detect contamination quickly and accurately remains a major challenge in many parts of the world. Researchers at the National University of Singapore (NUS) have developed a groundbreaking new device that could revolutionize how water quality is monitored and managed.

This concept was derived from the biological function of the oily protective layer on human skin and was translated into a versatile material, known as ReSURF, which can spontaneously form a water-repellent interface by researchers led by Associate Professor Benjamin Tee from the Department of Materials Science and Engineering in the College of Design and Engineering at NUS. This new material, which can be prepared through a rapid micro-phase separation approach, autonomously self-heals and can be recycled. The researchers incorporated the material into a device known as a triboelectric nanogenerator (TENG), which uses the energy from the movement of water droplets to create an electric charge. The resulting device (ReSURF sensor) can be applied as a water quality monitor.

â??The ReSURF sensor can detect various pollutants, such as oils and fluorinated compounds, which are challenging for many existing sensors. This capability, together with unique features such as self-powered, self-healing, reusability and recyclability, positions ReSURF as a sustainable solution for real-time, on-site, and sustainable water quality monitoring,â? said Assoc Prof Tee.

Rapid and sustainable water quality sensing

Existing water quality monitoring technologies such as electrochemical sensors, optical detection systems, and biosensors are effective in certain specific applications, such as detecting heavy metals, phosphorus, and microbial pollution. However, these technologies often face limitations including slow response, high costs, reliance on external reagents or power sources, limited reusability, and the need for bulky laboratory equipment or specialised instrumentation.

The ReSURF sensor developed by the NUS team effectively overcomes these challenges, particularly in on-site real-time water quality sensing. The self-powered device has demonstrated the ability to detect water contaminants in approximately 6 milliseconds (i.e. around 40 times faster than a blink of the eye).

Additionally, the ReSURF sensor is designed to be self-healing and recyclable, making it a sustainable and low-maintenance solution. Being stretchable and transparent, the material can be easily integrated into flexible platforms, including soft robotics and wearable electronics, setting it apart from conventional sensing materials.

Furthermore, the ReSURF material applied as a sensor offers an environmentally friendly solution as it can be easily recycled due to its solubility in solvents, enabling it to be reused in new devices without suffering a loss in performance.

The ReSURF sensor monitors water quality by analysing the electrical signals generated when analytes â?? such as salts, oils, or pollutants â?? in the water droplets, contact its surface. When water droplets containing analytes strike the water-repellent surface of the sensor, they spread out and slide off quickly, generating electric charges within milliseconds. The magnitude and characteristics of the signal generated would vary according to the composition and concentration of the analytes present. By monitoring these signals in real time, the ReSURF sensor can rapidly and accurately assess water quality without the need for external power sources.

The ReSURF sensor offers broad application potential. It can be deployed in rivers, lakes, and reservoirs to enable early surveillance of pollutants, allowing for quick response to water contamination emergencies. In agriculture, it is capable of monitoring water safety in areas like rice fields. In industrial settings and sewage treatment plants, the ReSURF sensor could provide valuable insights for wastewater management.