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Singapore's SERS Chip to Combat Air Pollution

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Researchers at the School of Chemistry, Chemical Engineering, and Biotechnology at Nanyang Technological University Singapore (NTU Singapore), led by Prof Ling Xing Yi, have made a surface-enhanced Raman scattering (SERS) chip that can quickly and accurately find sulphur dioxide (SO_2) and nitrogen dioxide (NO_2). These gases are emitted by automobiles and factories and have been linked to acid rain and breathing problems.

Gas chromatography and other common analysis methods are often used to find and measure SO_2 and NO_2 gases. But these kinds of tests must be done in a lab, can't always find gases at low amounts, and are expensive. SERS technology, on the other hand, might be able to find pollutants in much lower amounts and is cheaper to run.

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SERS works by making the signal from each molecule's scattered light stronger. When light is shone on a molecule, it spreads the light and makes what is called a spectrum. Like a fingerprint, each molecule has its range.

With SERS, the molecules of interest stick to a surface, like metal nanoparticles, and light from a laser excites them. The metal substrate makes the light-scattering signature stronger, which makes it possible to identify molecules at low concentrations with high sensitivity.

By looking at the SERS spectra, scientists can determine what chemicals are in a mixture. SERS can be used to do a lot of different things, like find biomarkers to help diagnose diseases or keep an eye on dangerous pollutants in the environment.

However, it is still hard to get low concentrations of gases to stick to the SERS substrate, and using the technology to identify gases is still a work in progress. This was the goal of a recent study that made a 1 cm by 1 cm chip that can measure and identify both gases at the same time.

Scientists tested how well the chip could pick up SO2 and NO2 in exhaust gases by exposing it to a mixture of SO2, NO2, and CO2, which was meant to look like car exhaust.

Climate change and pollution are two of the biggest problems that people face today. Being able to accurately identify gaseous molecules at low concentrations makes it easier to enforce environmental policies that will help solve these problems.

The results also show how machine learning (ML) and other forms of artificial intelligence (AI) could be used to improve the study of SERS spectra.

There are plans to make the test chip even better. Even though the study found that CO2 in the exhaust doesn't change how much SO2 and NO2 can be measured, more research needs to be done to find out if other gases make it harder for the chip to find polluters.

The price of Raman spectroscopy and the size of the spectrometer are also important factors that affect how the chip can be used to track emissions from cars and factories. In the future, the chip could be used as a sensor for on-site spying with the help of handheld or portable Raman spectrometers.

Using what they learned from their study, the researchers are now trying to make the platform able to find other gaseous pollutants like chlorine, bromine, ammonia, and ethylene oxide. In the future, they want to put the chip into a high-throughput data collection system that will let the SERS spectra be collected automatically for environmental tracking.