



Technology Frontier

News Bite on PolyU's Innovation

Atmospheric Acidic Ultrafine Particle Measuring Device Making further research on the ultrafine particles possible

Acidic airborne particles such as sulphur and nitrogen derivatives may cause health problems. Acidic ultrafine particles (AUFPs) in nano-scale may also lead to climate issues. However, there is no established health standard on AUFPP concentration, just because there has not been a way to accurately measure it. Researchers from the Department of Civil and Environmental Engineering thus developed the Atmospheric Acidic Ultrafine Particle Measuring Device, to enable further research and health standard establishment.



Prof. Hai Guo (right) and his research team member from the Department of Civil and Environmental Engineering

Air pollution is harmful to human health. Power plants and industrial processes are responsible for the emission of sulphur dioxide and nitrogen oxide. Such pollutants can be oxidized by oxidants such as ozone and hydroxyl radicals to form acidic aerosols, which are proven to cause lung damage and are linked to higher mortality rate in humans. Those acidic aerosols of sizes below 100 nanometres are considered acidic ultrafine particles (AUFPPs), and on top of health concerns, they also have implications on climate and visibility. That being said, researches on AUFPPs have been difficult and few and far between,

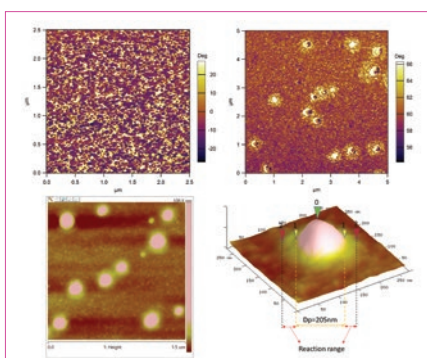
because these particles are so small and light that there has not been any effective way to measure their concentration in air. In light of this, Prof. Hai Guo, Department of Civil and Environmental Engineering, led a research team to develop the Atmospheric Acidic Ultrafine Particle Measuring Device, providing accurate reading of airborne AUFPP concentration, laying a solid foundation for further research on their effects on climate and human health.

Lack of AUFPPs related health standards

Apart from adverse health effects, AUFPPs also account for low visibility



Atmospheric acidic ultrafine particle measuring device



Acidic ultrafine particles on crystal oscillators



The atmospheric acidic ultrafine particle measuring device won a gold medal and a special merit award at the 71st International Trade Fair for Ideas, Inventions & New Products (iENA) in Germany.

and may probably affect the climate system. They are so small and light that they suspend in the air to be the seeds for water to adhere to. Worse still, their acidic nature actually makes them attract water more readily. After the particles are covered in water, they tend to scatter light like fog, impairing visibility. Despite the health and climatic implications of AUFPs, there is not an established health standard for AUFPs so far. It is because there has not been a reliable and accurate way to measure airborne AUFPP concentration. "That's why, as the first step, we need to develop a measuring device for AUFPPs, so that there is a consistent standard for researchers to build more data, before they can find out the relationship between AUFPPs and human health or climate. In other words, our invention is the foundation and the beginning of a new stream of research," said Prof. Guo.

Atmospheric AUFPP measuring device

The device that the team developed has three components: a diffusion sampler, a light pump and quartz crystal microbalance (QCM) detectors. The QCM detectors are located inside the diffusion sampler. When the light pump draws air slowly through the diffusion sampler at an even flow rate, maximum amount of ultrafine

particles are collected on the detectors. "You may think of the QCM detector as a very sensitive scale that can measure the mass of nano-scale particles. Inside a detector, the quartz crystal oscillator gives a signal of very precise frequency. When a particle hits the detector, the frequency would change. The change in frequency can be calibrated to tell the weight of each particle," explained Prof. Guo. The total change in frequency and hence the change in mass are noted to determine the total amount of particles collected.

In order to single out the AUFPPs from other non-acidic ultrafine particles, the team coated the QCM detectors with a metal nano-film so that acidic particles, not non-acidic ones, will bond firmly with the detectors. Then the non-acidic particles are removed from the detectors with ultrasonics and an organic solvent. The changes in mass on the detectors are measured again. The remaining mass will tell the concentration of AUFPPs.

In November 2019, the Atmospheric Acidic Ultrafine Particle Measuring Device won a gold medal and a special merit award at the 71st International Trade Fair for Ideas, Inventions & New Products (iENA) in Nuremberg, Germany.