# Organic films from atmospheric aerosol and sea water

May 29 2017

Tiny particles in the air known as aerosols play an important role in cloud formation, which in turn has an impact on our planet's climate. However to date the effect of aerosols on cloud formation remains full of uncertainties. Among these uncertainties is the reactivity of organic films that have been found to coat atmospheric aerosols. Now researchers have turned their attention to studying these using the

Surface and Interface Diffraction beamline (I07) at Diamond Light Source.

In work recently published in *Atmospheric Environment* researchers investigated the reactivity of the organic films found at an aerosol's surface. After extracting the organic material from atmospheric aerosol samples they placed it on an air-water interface, exposed to ozone gas. Ozone is a common atmospheric oxidant. Through X-ray reflectivity measurements gathered at Diamond's I07 beamline, they very surprisingly found that the organic samples were inert to oxidation by ozone gas. However, the samples did react when exposed to hydroxyl radicals under the same conditions.

To explain the lack of reaction with ozone, the team propose that the samples collected may contain higher quantities of saturated than unsaturated material. They say that their results indicate that atmospheric aerosols might be less reactive in the atmosphere than previously thought. They now plan to test this theory by investigating further organic samples taken from different types of atmospheric aerosols in order to map their reactivity.

## Clouds and our climate

The clouds in our atmosphere have a significant effect on the Earth's climate, as they are incredibly reflective, bouncing a significant proportion of the Sun's light back into space. The reflection acts to cool the planet's surface, with their cooling effect being almost as large as the warming impact of greenhouse gases.

Key to the formation of clouds are aerosols, tiny particles in the air around which water droplets condense to eventually form clouds. All cloud droplets in the atmosphere have formed on atmospheric aerosols. If the chemical properties of the aerosols are modified they can affect the size and number of cloud droplets within a cloud, the amount of rainfall and how much light is reflected back to space. Changing the size and number density of cloud dropelts changes the reflectivity of the cloud. "A small chemical change can cause a climatic difference," says Professor Martin King, from Royal Holloway University of London and corresponding author on the study.

Studies have shown that these aerosols are often coated in organic films, which might affect the overall reactivity and behaviour of these type of particles. So, to discover more about the properties of the aerosols that lie at the heart of cloud formation, Professor King and his colleagues including researchers from the Laser Science Facility (RAL) and Uppsala University, turned their attention to the films.

**Beamline techniques**

The team extracted the organic matter from samples of atmospheric aerosols before placing the material on an air-water interface and exposing the sample to ozone gas. This was the first time real life samples of the films had been investigated, as previous studies have all used proxies for the organic films.

To determine whether the films reacted with ozone the team used X-ray reflectivity measurements at Diamond's Surface and Interface Diffraction beamline (I07). The X-ray measurements provided information on the change in thickness and identity of the film before and after exposure to ozone.

The I07 beamline offered extremely good signal-to-noise up to high reflection angles and a fast acquisition of data, features that were critical for this type of experiment. "The samples were very difficult," says Professor King, "they essentially looked like dirty water." As the team were new users the Diamond staff were a critical part of the studies and helped them to achieve useable results. The geometry of the beamline was also important – allowing the team to deflect the X-ray beam whilst keeping the sample horizontal, enabling them to bounce off the surface of the liquid. This is an experimental arrangement only available at a few synchrotron beamlines worldwide.

## Conclusions

Surprisingly the team found that the organic sample was inert to oxidation by ozone. However, when the experiment was repeated with hydroxyl radicals, a reaction between the film and radical did take place. The researchers say the results indicate that the organic films in the sample are composed mainly of saturated, rather than unsaturated material. This was supported by gas chromatography and electrospray ionisation mass spectrometry studies.

"It was an unexpected and unusual result," says Professor King. The team suggest that the unreactivity of the organic samples might be due to how long they had been in the atmosphere. They now plan to test other samples taken from different environments, such as pine forests where aerosol particles are freshly formed, to map how their behaviour may differ.

**More information:** Stephanie H. Jones et al. Are organic films from atmospheric aerosol and sea water inert to oxidation by ozone at the air-water interface?, *Atmospheric Environment* (2017). DOI: 10.1016/j.atmosenv.2017.04.025

Provided by Diamond Light Source