Case Study

How does ozone exposure harm your lungs?

The Problem

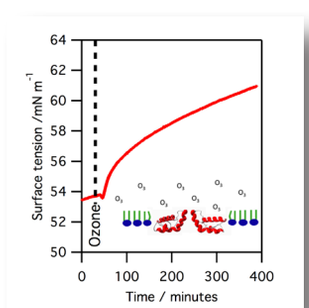
Lung surfactant proteins are essential proteins found in the surfactant layer at the air-water interface of the lung. They provide the first line of defence for the body when exposed to ozone, present as a secondary pollutant in ambient air. It is known that ozone exposure can cause respiratory distress and can lead to increased hospital admissions and even death. The actual mechanism by which ozone disrupts the respiratory system is not well understood.

The Challenge

A range of lipids, peptides and proteins are required for correct respiratory function. The presence of a mixture of phospholipids is considered important to provide fluidity and support the dynamic behaviour of the otherwise rigid lipid layer. Understanding how the structure of the complex lung surfactant layer changes on oxidation by ozone is key to understanding the mechanism of respiratory distress. High resolution surface sensitive experiments on fast time scales were needed to understand the changes in the layer structure occurring during ozone exposure.

The Solution

The team of scientists from Birkbeck College, University of London and Uppsala University, used beamline I07 to investigate a peptide analogous to a lung surfactant protein at the air-water interface using X-ray reflectivity in combination with neutron measurements. The peptides were examined under oxygen flow and then under a dilute flow of ozone in oxygen, with continuous monitoring by X-ray reflectivity to investigate interfacial structural changes. The results show that the peptide oxidises rapidly when exposed to ozone at the air-water interface and remains at the interface, slowly undergoing a conformational change to a more hydrophobic material.



The Benefits

The results provided a better understanding of how the inhalation of ozone leads to respiratory distress. They clearly demonstrate how the peptides related to a lung surfactant protein can be oxidised by ozone leading to a substantially altered lung surfactant layer. Further work can now focus on understanding this behaviour in the presence of other lipids.

"Access to Diamond's I07 beamline has allowed us to study the damage caused by the common environmental pollutant ozone to the fluid layer that lines the outer surface of the lung. The X-ray reflectivity measurements are sensitive to changes happening right at the interface between the inhaled air and the lung itself. Thanks to this excellent facility we now have a better understanding of the nature of the damage caused by exposure to low levels of ozone in polluted air."

Dr Katherine Thompson, Birkbeck College, University of London

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