Chemical and Physical Changes of Organic Particles Upon Reaction with Ozone

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Abstract

PSL particles are coated with oleic acid of variable layer thickness (2-30 nm) and exposed to variable ozone concentrations at low relative humidity. An aerosol mass spectrometer (AMS) shows that as oleic acid (OA) decreases with increasing ozone exposure, 9-oxononanoic acid (OA9) (20.35%), 9-oxononanoic acid (AA9) (3.37%), and 9-oxononanoic acid (NA9) (11.7%) form. The particles evaporate by up to 30%, and 1-nonal (NN) is assumed to be the volatile product. The relative product yields depend on whether the reactions occur in the surface or bulk regions of the particle. After accounting for the identified fragments, a residual mass spectrum remains (35-50%). Important marker peaks occur at 155, 221, and 265 amu suggesting that the carbon chains are longer than 9. We probe the change at 155 amu for normalized ozone exposure up to 3.0 and observe a continuous increase of the signal. An increase in the carbon-normalized oxygen content (C/O) in the average chemical composition of the layer is observed after high ozone exposure.

Results

Reaction Products Quantification

Effect of Layer Thickness

Surface reaction for CHOy formation occurs at greater yield than its bulk counterpart and vice-versa for OA.

No discerned trend for the AA and NA

Density of Reacted Layers

Two Distinct Calculation Methods

Density increases

Increasing aerodynamic diameter
Decreasing mobility diameter
Decreasing layer mass
Therefore, increasing density

Formation of Large Organic Molecules

Proposed Mechanism

New mechanism proposed.

Conclusions

Significance of Atmospheric Particles: Climate and Chemical Reactions

What’s next ...

- Study of the hygroscopic response of reacted particles at high relative humidity.

Hypothesis: Particle hygroscopicity and hence efficacy as cloud condensation nuclei increase during transport and chemical reactions of particles with atmospheric oxidants.

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