Do surface reactions influence formation of secondary organic aerosol?

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Introduction

Previous research has focused on the formation of secondary organic aerosol (SOA) due to ozone and terpene homogenous reactions. The purpose of this paper is to present indirect evidence that surface reactions between ozone and terpenes adsorbed to interior building surfaces can also contribute significantly to SOA formation.

Contribution from surface reactions

A field study was conducted in which an ozone-emitting ion generator was operated in a 27 m^3 residential room with a plug-in air freshener, which was a source of d-limonene. Different tests were conducted with the original floor surface of sealed/stained concrete, and with carpet and padding installed. The room air exchange rate during both tests was approximately 0.5 h^{-1}. Distinctive trends in SOA formation were observed depending on the flooring surface, as shown in Figure 1.

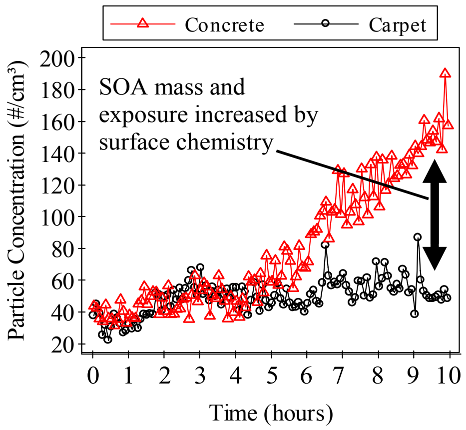

Figure 1. SOA formation (0.05–0.25 μm) in the same 27 m^3 room with different flooring.

Both tests exhibited similar SOA formation due to homogenous reactions during the first five hours. The test with the sealed/stained concrete floor exhibited a second increase in SOA mass, from the fifth hour to the end of the test, which we hypothesize is due to surface reaction products. We speculate that this process occurred as in Figure 2: (a) ozone and d-limonene adsorbed to the concrete and then (b) collided and reacted to form products, (c) which desorbed and condensed onto particles. Adsorbed d-limonene increased ozone flux to the otherwise low-reactivity sealed/stained concrete. Most of the ozone flux results in d-limonene conversion to SOA precursors.

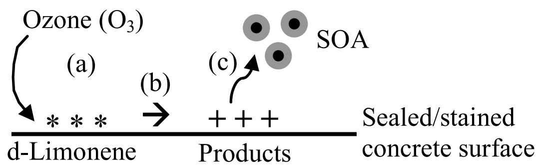

Figure 2. SOA formation by surface reactions.

However, ozone flux to the highly reactive carpet was large with, or without, adsorbed limonene. We hypothesize that carpet provided competing reaction sites for the ozone, which greatly lowered the rate of surface reactions between ozone and d-limonene relative to that which occurred on the sealed/stained concrete. All else being equal, low-reactivity surfaces result in a higher rate of SOA formation.

Conclusions

Ozone appears to react selectively with adsorbed terpenes on otherwise low-reactivity surfaces, which results in enhanced SOA formation. Furthermore, reactive surfaces may hinder SOA formation because ozone is consumed by competing surface sites. Thus, reactive surfaces could be engineered to simultaneously reduce indoor levels of ozone and SOA.