

Suppression of aerosol reactivity towards ozone by organic aerosol matter

A.M. Batenburg¹, C. Gaston², J.A. Thornton² and A. Virtanen¹

¹Department of Applied Physics, University of Eastern Finland (UEF), Kuopio, 70211, Finland

²Department of Atmospheric Sciences, University of Washington, Seattle, 98195, USA

Keywords: heterogeneous reactions, aerosol aging, aerosol oxidation, flow tube experiments, organics.

Presenting author email: annebatenburg@gmail.com

After aerosol particles are formed or emitted into the atmosphere, heterogeneous reactions with gaseous oxidants cause them to “age”. Aging can change the aerosols’ properties, such as their toxicity and their hygroscopicity. Hygroscopicity is an important parameter in determining how the particles scatter radiation and form clouds. Conversely, looking from a gaseous chemistry perspective, heterogeneous reactions on aerosol particles play a significant role in the cycles of various atmospheric trace gases.

Organic aerosol matter, a large part of the total global aerosol matter, can exist in liquid or amorphous (semi)solid physical phases (Virtanen *et al.*, 2010). Different groups have shown that reactions with ozone (O₃) can be limited by bulk diffusion in organic aerosol, particularly in viscous, (semi)solid materials (Shiraiwa *et al.*, 2011; Zhou *et al.*, 2012), and that organic coatings can alter the surface interactions between gases and aerosol particles (Thornton and Abbatt, 2005; Rouvière and Ammann, 2010). **We aim to better understand and quantify how the viscosity and phase state of organic aerosol matter affect gas-particle interactions.**

We have chosen the reaction of O₃ with particles composed of a potassium iodide (KI) core and a variable organic coating as a model system. The reaction is studied in aerosol flow reactors consisting of a laminar flow tube and a movable, axial injector for the injection of O₃. The aerosol-containing air is inserted at the tube’s top. The interaction length (and therefore time), between the particles and the O₃ can be varied by moving the injector. Alternatively, the production of aerosol particles can be modulated. The remaining O₃ concentration and the particle size distribution are monitored from the bottom of the tube. This allows us to calculate the reactive uptake coefficient γ , according to $\gamma=4k/(S\omega)$, where k is the first-order rate constant of the ozone loss, S is the aerosol surface area concentration, and ω is the mean molecular velocity of the O₃.

We performed exploratory experiments with internally mixed KI and polyethylene glycol (PEG) particles at the University of Washington (UW) in a setup with an approximately 50 s residence time. Aerosol particles were generated in an atomizer from solutions with varying concentrations of KI and PEG, diluted with humidified air, and inserted into the flow tube after excess pressure was vented. It proved necessary to separate the particles before the O₃ monitor to prevent interference with the optical O₃ detection method. Unfortunately, large O₃ losses occurred on the used filter, which limited the accuracy of the γ -determinations. Nevertheless, it was found that already a

small amount of added PEG considerably reduced the observed γ .

We are currently reproducing these experiments in Kuopio, with a setup where the particle separation is achieved with a passive DMA tube instead of a filter. The first results from these experiments seem to confirm that adding PEG reduces the reactive uptake.

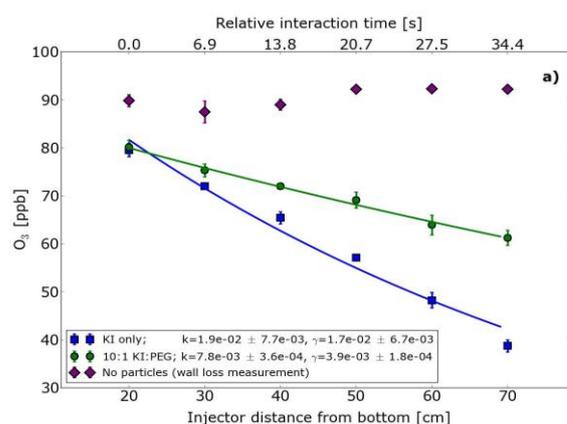


Figure 1. Decay curves obtained at UW with pure KI particles (blue \square , from atomizer with 0.003 M KI solution), particles coated with PEG (green \circ , similar KI solution with 0.0003 M PEG 400 added), and without particles (purple \diamond). Solid curves are exponential curve fits to calculate k and γ .

This work was supported by the Academy of Finland Finnish Centre of Excellence (decision no 272041), and by the Academy of Finland (decision no 259005).

- Shiraiwa, M., Ammann, M., Koop, T. and Pöschl, U. (2011), *PNAS*, **108**, 11003-11008, doi: 10.1073/pnas.1103045108
- Rouvière and Ammann (2010), *Atmos. Chem. Phys.*, **10**, 11489-11500, doi: 10.5194/acp-10-11489-2010
- Thornton, J.A. and Abbatt, J.P.D. (2005), *J. Phys. Chem.*, **109**, 10004-10012, doi: 10.1021/jp054183t
- Virtanen, A., Joutsensaari, J., Koop, T., Kannosto, J., Yli-Pirilä, P., Leskinen, J., Mäkelä, J.M., Holopainen, J.K., Pöschl, U., Kulmala, M., Worsnop, D.R. and Laaksonen, A. (2010), *Nature*, **467**, 824-827., doi:10.1038/nature09455
- Zhou, S., Lee, A. K. Y., McWhinney, R. D. and Abbatt, J. P. D. (2012), *J. Phys. Chem.*, **116**, 7050-7056, doi: 10.1021/jp3030705