

# The effect of hexanoic acid on the hygroscopic properties of sodium halide aerosols

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Atmospheric aerosols generally consist of inorganic species with a wide variety of organic compounds and elemental carbon. One of the types of aerosol in which we have focused our attention is sea salt aerosol. Those aerosols are mainly caused by ocean wave action and constitute the second most abundant type of naturally suspended particulate matter in the troposphere after dust aerosol (Seinfeld & Pandis, 1998). In addition, an appreciable fraction of organic material is present in marine sea salt particles. Much of the organic fraction correspond to water insoluble fatty acids (Donaldson & Vaida, 2006), such as hexanoic acid (HA) that is an intermediate between soluble and highly insoluble organic acids, and has higher vapor pressure than the atmospherically more abundant acids. Fatty acids are presented as surface films on marine aerosols and that can affect properties such as hygroscopicity, phase transition or chemical reactivity. Despite the importance of this subject there is a lack of knowledge in the physical changes.

In the present work we study the hygroscopic properties of some submicrometric sea salt aerosols (NaCl, NaBr and NaI) coated with HA by Fourier-transform infrared spectroscopy in a flow cell. Infrared spectroscopy is a sensitive technique to characterize aerosol composition, water content and particle phase. With this study we provide physicochemical information of the influence of halogen atoms in the NaX/HA system, spectroscopic results about the dynamic of heterogeneous nucleation and a complete study of hygroscopic processes in NaX/HA/H<sub>2</sub>O system.

HA phase in the particles has been spectroscopically monitored at given values of both relative humidity (RH) and HA/NaX solute mass ratio. The obtained results indicate that the gaseous HA easily nucleates onto dry and aqueous NaX particles. Furthermore, our results show that the amount of dissolved HA in the aqueous particles is negligible compared to the total amount of deposited HA. For this reason, we assume that practically all HA will be found on the surface of the particles. On the other hand, the evolution of the amounts of liquid HA on aerosols with RH shows that gaseous water molecules tend to displace HA molecules away from the particle surface, to energetically stabilize the system as the RH is increased.

Another important point is that the results on water uptake and release in HA covered particles reveal that the organic compound does not appreciably alter the hygroscopic processes for NaCl/HA with respect to the pure NaCl particles, whereas NaBr and NaI particles covered by HA deliquesce at higher RH and uptake water more abruptly than the pure inorganic particles. In

contrast, efflorescence process in NaX aqueous particles is not substantially affected by the presence of HA.

Our results suggest that the surface properties of sea-salt particles may be more complex than model predictions, because, as bromide and iodine ions tend to segregate to the surface of particles, the effect of fatty acids can be different for each Cl/Br/I ions. Moreover, at given conditions of atmospheric RH, the amount of liquid water and the phase of sea-salt particle outer core may vary with respect to the expected behavior of pure NaCl particles. We are extending our investigation to more organic compounds to study the influence of the chain length of the fatty acid.

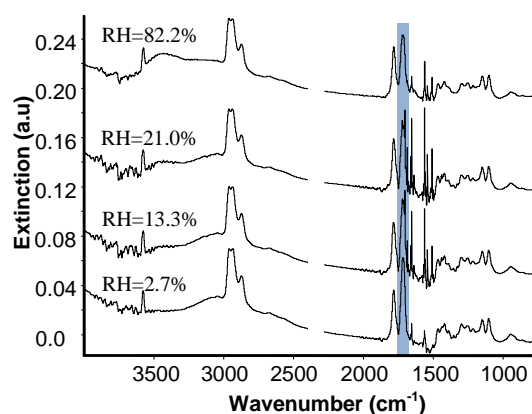


Figure 1. Infrared extinction spectra of NaI particles after passing through a heated cell containing HA exposed to different RHs. The presence of liquid water can be detected by the broad band centered at near 3400 cm<sup>-1</sup>. It can be seen that the band intensities of liquid HA ( $\approx 1710$  cm<sup>-1</sup>, coloured) decrease as RH increase.

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## References

- Seinfeld, J. H., Pandis, S. N. (1998) *Atmospheric Chemistry and Physics*; John Wiley; New York.
- Donaldson, D. J., Vaida, V., 2006, *Chem. Rev.*, 106(4) doi: 10.1021/cr040367c.