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Study on HCl Driving Force for the Reaction of NaCl-Maleic Acid Mixing Single Droplet Using Micro-FTIR Spectroscopy

Xiang He and Yunhong Zhang

Institute of Chemical Physics, School of Chemistry, Beijing Institute of Technology, Beijing 100081, China(yhz@bit.edu.cn)

Chemical aging is the one of the most important physicochemical process in atmospheric aerosols. Mixing of sea salt and water-soluble organic components has profound effects on the volatile characteristic and evolving chemical composition of the anthropogenic origin aerosols, which are poorly understood. In this study, the chemical reaction behavior of the mixture of NaCl and maleic acid (H_2MA) micron-level single droplet was investigated using a gas-flow system combined with microscopic Fourier transform infrared (micro-FTIR) spectrometer over the range of relative humidity (63∼95% RH) for the first time. The results showed that the mixture of NaCl and H_2MA single droplet could react to form monosodium maleate salt (NaHMA) at the constant RH from the characterization of the FTIR. The reaction is a result of an acid displacement reaction R1, which is driven by high volatility of the HCl product.

NaCl(aq)+H_2MA(aq)=NaHMA(aq)+HCl(aq,g) (R1)

According to the change tendency of the absorbance values of 1579 cm^{-1} COO^- stretching band of the NaHMA dependent upon reaction times at different RHs, the growth range of the trend which could lead to the faster reaction rate was obvious at lower RH. The water content of the droplet was also more likely to reduce rapidly with the loss of the RH from the absorbance changes of 3400 $cm^{-1}H_2O$ stretching band dependent upon reaction times. These may be due to irreversible evaporation of HCl gas which is the main driving force for this type of reaction and the NaHMA is a less hygroscopic component compared to H_2MA. And the HCl gas is more likely to evaporate faster from the single droplet and promote the reaction rate and the consumption of water content at lower RH. These results could help in understanding the chemical conversion processes of water-soluble dicarboxylic acids to dicarboxylate salts, as well as the consumption of Cl in sea salt aerosols by organic acids in the atmosphere.