

Hygroscopicity and evaporation of ammonium chloride and ammonium nitrate: relative humidity and size effects on the growth factor

Dawei Hu[†];

[†]Fudan University, China, People's Republic of

Leading author: 072047013@fudan.edu.cn

The hygroscopicity and evaporation of ammonium chloride and ammonium nitrate in the size range of 40-200 nm are investigated from 20% to 86% RH using a self-assembled hygroscopic tandem differential mobility analyzer (H-TDMA) system. The hygroscopicity of 100 nm ammonium sulfate is also measured for comparison. The measured hygroscopic growth factors (GFs) of ammonium sulfate agree well with the theoretical Köhler curve. Great discrepancies between the measured GFs and the theoretical values are observed for ammonium chloride and ammonium nitrate due to their volatile properties. The evaporation of ammonium chloride below the deliquescence RH (DRH) is significantly promoted while RH increases. Similar trend is also observed for ammonium nitrate particle less than 50 nm. The proposed mechanism suggests that the increase of RH alters the chemical equilibrium among $\text{NH}_4\text{X}(\text{s})$ (X represents Cl^- or NO_3^-), $\text{NH}_3(\text{g})$ and $\text{HX}(\text{g})$, i.e. $\text{NH}_4\text{X} \leftrightarrow \text{NH}_3(\text{g}) + \text{HX}(\text{g})$, by converting $\text{NH}_3(\text{g})$ and $\text{HX}(\text{g})$ into $\text{NH}_3 \cdot n\text{H}_2\text{O}$ and $\text{HX} \cdot n\text{H}_2\text{O}$, which accelerates the evaporation of $\text{NH}_4\text{X}(\text{s})$. When RH is higher than the DRH, the GFs of NH_4X increase with initial particle size throughout the investigated size range. In this study, the iso-GF curves are also drawn to illustrate the effects of initial particle size and RH on the GFs. Different from $(\text{NH}_4)_2\text{SO}_4$, NaCl, Na_2SO_4 and NaNO_3 , the GFs of NH_4X are more sensitive to initial particle size than RH due to the unique volatility of ammonium chloride and ammonium nitrate.