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Hygroscopic properties of sodium chloride nanoparticles

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Salt particles deliquesce at a range of relative humidity values to become solution droplets of increased
The deliquescence relative humidity (DRH) of particles larger than the nano-size regime is only a fu
their chemical properties and not of their size. Nanoparticles, on the other hand, do not have the same b
as has been shown by a small number of experimental studies (Hämeri, Väkevä et al. 2000; Hämeri, La
et al. 2001) and theoretical calculations (Mirabel, Reiss et al. 2000; Djikaev, Bowles et al. 2001; Rus
Ming 2002). This small number of experimental studies and the contradicting theoretical predictions u
the need for further experimental evidence.
This paper presents measurements of the hygroscopic behavior of sodium chloride particles in the
range of 6-60 nm. In particular, because of much discussion in the literature concerning, on the one h
challenges of preparing pure nano-particles and, on the other hand, the importance of the relationship
DRH and purity, we generate NaCl nanoparticles by two independent methods.
The experimental apparatus consists of two nano-DMAs (TSI Model 3085), a nanoparticle CPC (TS
3025A), and a series of Nafion-tube humidity exchangers. Polydisperse sodium chloride aerosol sa
low relative humidity (RH<5%), generated either by an electrospray generator (TSI Model 3480
vaporization-condensation approach, are passed through a 210Po neutralizer and the first nano-DM
apparatus. The resulting monodipserse aerosol is then directed through the Nafion-tube humidity ex
where its RH can be accurately adjusted. The size distribution of the hydrated aerosol is measure
second nano-DMA and the nanoparticle CPC.
The results show that sodium chloride nanoparticles deliquesce at higher relative humidity values, c
to particles larger than 20-nm mobility diameter. Moreover, the hygroscopic growth factors of the
particles are lower than those of the larger particles and depart from the thermodynamic predictions. Th
are compared with theoretical predictions available in the literature. Importantly, the behavior of the
generated by the two different and independent methods (viz. electrospray and evaporation/condensatio
very well with each other, which rules out the possibility that impurities affect our measurements.
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