Atmospheric Particles

The interconversion of atmospheric organic particles among solid, semisolid, and liquid phases is of keen current scientific interest, especially for particles of secondary organic material (SOM). Herein, the influence of phase on ammonia uptake and subsequent particle-phase reactions was investigated for aerosol particles of adipic acid and β-pinene ozonolysis SOM. The nitrogen content of the particles was monitored by on-line mass spectrometry for increasing ammonia exposure. Solid and semisolid adipic acid particles were inert to the ammonia uptake for low RH (< 5%). For the solid particles, ammonia exposure at high RH (> 94%) induced a first-order deliquescence phase transition into aqueous particles. Solid particles exposed to supersaturated (RH > 100%) conditions and cycled back to high RH (RH > 94%), thereby becoming acidic metastable particles, underwent a gradual second-order transition upon ammonia exposure to form aqueous, partially neutralized particles. For β-pinene SOM, ammonia exposure at low RH increased the particle-phase ammonium content by a small amount. Mass spectrometric observations suggest a mechanism of neutralization and co-condensation of acidic gas-phase species, consistent with a highly viscous semisolid upon which adsorption occurs. At high RH the ammonium content increased greatly, indicative of rapid diffusion and absorption in a liquid environment. The mass spectra indicated the production of organonitrogen compounds, possibly by particle-phase reactive chemistry. The present results demonstrate that phase can be a key regulator of the reactivity of atmospheric SOM particles.