Phase Transition in Optically Trapped Aqueous Glycine Controlled by Radial Inhomogeneity

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Submicron to micron-sized aqueous aerosol droplets experience high supersaturation during their transport in the atmosphere. However, phase transition in such metastable droplet remains difficult to study. Here, we show that phase transitions of glycine droplets (1-4 um in radius) induced by a rapid decrease in the relative humidity (RH) is controlled by radial inhomogeneity of the concentration in the droplet. Upon drying of single droplets in optical tweezers from 65-80% to 25% RH, they decrease in size by water evaporation. Although the droplet radius decreased rapidly (~1 $\times 10^{-9}$ m s^{-1}) at RHs higher than ~50%, the droplet shrinking is suppressed at lower RHs. This could be induced by the formation of a viscous shell. We frequently observed that supersaturated droplets irreversibly transformed to b-glycine for large particles (> 2 um) with low particle shrink rates. In contrast, smaller droplets (< 1.5 um) rarely showed crystallization. Shrinking of the smaller droplets accelerates at particle size < 1.1 um, indicating that the viscous shell is disappearing. Furthermore, crystallization is suppressed because of the smaller particle volume and increased viscosity. Radial inhomogeneity caused by rapidly drying aqueous glycine might enhance the probability of crystallization. We suggest that the formation of a viscous shell in rapidly drying aqueous droplet could causes significant variations in size, phase, morphology and chemical composition of atmospheric aerosols.

Keywords: counter propagating optical tweezers, inhomogeneity, crystallization

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