

Charge Instability Induced Breakups of Droplets Containing Ionic Solutes and Suspended Nanoparticles

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We have examined the charge stability limits of single evaporating microdroplets containing ionic solutes and nanoparticles. Droplets were suspended in an electrodynamic balance, and a high precision light scattering technique based on optical resonances was used to determine the size and the size change of a droplet at a charge instability induced breakup. The charge level and the charge loss at a breakup were obtained from the dc voltages required to gravitationally balance the droplet prior to and following the breakup. We have examined diethylene glycol (DEG) and triethylene glycol (TEG) droplets containing lithium chloride (LiCl) as well as suspended polystyrene nanoparticles at varying concentrations. While results on pure droplets of DEG and TEG show that breakups due to the charge instability occur at the Rayleigh limit, droplets containing LiCl solute explode at significantly higher charge levels than the Rayleigh limit. Similar results were observed in droplets containing nanoparticles, that is, a droplet can remain stable at a charge density level greater than three times the Rayleigh limit. The results indicate that the charge stability limit depends on the concentration of solute or nanoparticles as well as the size of nanoparticles in the droplet.