Effects of charge fluctuation on aerosol dynamics and thermal behavior

of nanoparticles in dusty plasma

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Particles immersed in a plasma undergo charge fluctuation due to collisions with ions and electrons which has a strong bearing on their aerosol dynamics and thermal balance. As a matter of fact, a significant fraction of nm-sized particles can be non-negatively charged which enhances the coagulation kinetics and as a consequence, affects the particle size distribution. Also the collisions with ions and electrons is accompanied by large amounts of energy deposition on the particle. Especially the small nm-sized particles can undergo temperature fluctuations with high peak values that determine the crystallinity of the Nps.

In this presentation, we analyze the particles behavior in plasmas using detailed aerosol modeling in DC discharge combined with theoretical models for charge and thermal fluctuations. We showed that taking into account the discrete nature of the charge distribution is of prime importance to estimate the fraction of non-negatively charged particles. This results in the appearance of several particle generations, i.e. modes, and lower density and slightly larger diameter of the core distribution.

We also showed that for carbon nps in a typical processing discharges, the particles of size <5 nm diameter can attain peak temperatures as high as 2000 K, which explains the fact that small particles are usually crystalline while large particles are amorphous in nature [1].

[1] C. Arnas, and A. Mouberi, “Thermal balance of carbon nanoparticles in sputtering discharges,” *Journal of Applied Physics,* vol. 105, no. 6, pp. 063301, 2009.