GEC17-2017-000311

Abstract for an Invited Paper
for the GEC17 Meeting of
the American Physical Society

Solvated electrons and plasma – liquid chemistry in plasma exposed microdroplets[1]

PAUL MAGUIRE, University of Ulster

Transport of micron-sized liquid droplets through a low temperature atmospheric pressure RF plasma [1] has demonstrated some remarkable effects. After a short flight time, ~120 us, rapid plasma-induced nanoparticle chemical reactions have been observed, significantly faster than observed in plasma – bulk liquid studies and many orders of magnitude faster than in standard bulk chemistry. The microdroplet system allows for a controlled gas environment, a large surface area to volume ratio, very small reaction volume, low droplet temperature, in-flight chemical synthesis and encapsulation of nanoparticles, and their remote delivery. Nanoparticles can be formed without surfactant or surface ligands and can be delivered to surfaces, cells or liquid downstream. The in-droplet synthesis rate of nanoparticles was estimated to be at least 7 orders of magnitude faster than standard synthesis processes involving colloidal chemistry. It was also much faster that approaches based on microfluidic microreactors or high energy radiolysis.[2] The droplet chemistry leading to nanoparticle formation is complex. The plasma feed gas contains only noble gases along with H_2O from the evaporating droplet. Other observed chemical species in the liquid are H_2O_2 and OH, most likely due to generation of these species in the plasma phase. The H_2O_2 concentration reached 30 mM after 120 us plasma exposure. The degradation rate of Methylene Blue dye due to OH radical bombardment was observed with varying distance up to 150 mm from the plasma source. Results from radial diffusion reaction simulations will be presented. [1] PD Maguire et al., Appl. Phys. Lett. 106, 224101 (2015) [2] PD Maguire et al., Nano Lett., 17, 1336–1343 (2017)

[1]Funding from EPSRC acknowledged (Grants EP/K006088/1 and EP/K006142/1)