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His interests focus on low-temperature plasmas at atmospheric pressure and their interactions with liquids and solids. He has published widely on plasma - nanomaterials synthesis at atmospheric pressure for applications in energy and environment such as 3rd generation photovoltaics and volumetric solar thermal technology. With respect to plasma – liquid interactions, his specific interest is in Droplet in Plasma systems for remote plasma medicine, agriculture and nanomaterials delivery applications. He has also interests lie in the development and integration of microplasma, microfluidic and microfabrication techniques for application in new biomedical and environmental sensors devices; current projects include deep ocean chemical analysis and real-time virus detection (VIPIRS) as well as plasma-based manufacturing. Current research grants

ABSTRACT.
Microdroplets represent an important element in a number of fields from electrospray (ESI) mass spectrometry to atmospheric chemistry and microfluidic reactors. The observation of enhanced reaction rates in gas-phase microdroplets, often by orders of magnitude, compared to bulk liquids has sparked considerable research interest. Accelerated reactions have been observed for a wide range of chemistries and a number of mechanisms have been proposed to account for the acceleration. In particular, due to the prevalence of ESI, the influence of excess charge and electric fields, whether externally applied or arising intrinsically due to water molecule reorientation, is of fundamental importance. However, ESI precludes study of in water reactions as evaporation and ion release to the gas phase is the primary objective.

We have observed chemical electron reduction reactions in plasma-exposed microdroplets that are many orders of magnitude faster than bulk solution chemistry, radiolysis or electron beam irradiation. We have also observed rapid biological reactions on single cells carried in microdroplets. With Droplet in Plasma systems, the high flux of gas-phase radicals and charged species play a decisive role in addition to reaction acceleration factors under consideration in non-plasma systems. For many reduction reactions, solvated electrons sourced from the gas phase are the primary candidate. Rumbach et al.[1] have measured the solvated electron density in bulk liquid due to plasma exposure but little is known with regard to microdroplet conditions. Measurement and simulation of charge flux to particles in plasmas has a long history for scientific and technology reasons, e.g. dusty plasmas. However, while charging theories are well established for low pressure non-thermal conditions, the long-standing charge models (e.g. Su and Lam[2]) and simulations (e.g. Patacchini and Hutchinson[3]) for particle charging under highly collisional conditions have not been validated experimentally. In this talk, the first charge measurements will be presented for water microdroplets transported through an atmospheric pressure plasma.

1. Rumbach, P., *et al.* The solvation of electrons by an atmospheric-pressure plasma. *Nat Commun* **6,** 7248 (2015). https://doi.org/10.1038/ncomms8248
2. C. H. Su and S. H. Lam, Continuum Theory of Spherical Electrostatic Probes, Phys. Fluids 6, 1479 (1963) http://dx.doi.org/10.1063/1.1710971
3. L. Patacchini *and* I. H. Hutchinson, "Continuum-plasma solution surrounding non-emitting spherical bodies", Physics of Plasmas 16, 062101 (2009) https://doi.org/10.1063/1.3143038