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Coding Plasma Chemistry for Cellular Metabolism

The reaction chemistry produced by low-temperature gas discharges is key to many applications including microelectronics fabrication, combustion, and cancer therapy. A common scientific question is whether key players in thousands of plasma reactions may be governed by a network of chemical pathways and how such a pathway network may be used for control and optimization of reaction chemistry. For plasma treatment of living cells, these are challenging questions. Cellular metabolism utilizes intracellular reactive species and nitrogen species (ROS, RNS) to achieve redox homeostasis, and the cell changes its redox homeostasis to adapt to external intervention. Effective cellular response represents a moving target to plasma chemistry. This has been a significant barrier to enabling a solid scientific foundation for plasma biomedicine.

One desirable role for plasma chemistry is to provide a trigger to coax the evolution of cellular redox homeostasis towards an intended path. The cellular redox machinery should remain as the main conductor for the orchestra of cellular functions and plasma ROS/RNS serves as a messenger to instruct change. As a messenger, exogenous plasma ROS/RNS must have concentrations below or near the physiological level of endogenous ROS/RNS. This seminar reports on progress of unraveling key aqueous reaction chemistry established by gas-phase plasmas and their underpinning network of chemical pathways using diagnostics and simulation in both gas and liquid phases. Results are used to examine possible initial cellular targets for aqueous plasma chemistry in the context of cancer cell metabolism and plasma treatment of leukemia. A speculative summary of what has been learnt and where future opportunities may be is provided.

About the Speaker: Michael Kong received his PhD in electrical engineering from University of Liverpool, UK in 1992, and was appointed as a lecturer (equivalent to assistant professor) in the same institute in 1995. In 1999, he moved to Loughborough University, UK where he became a chaired professor in 2004 and co-established in 2008 a campus-wide Center for Biological Engineering with a researcher population of 50-60. In 2012, he joined Old Dominion University as an endowed chair to focus on the interest of his lab in plasma biomedicine and bioelectrics. He has published some 160 journal papers in diverse fields including low-temperature and arc plasmas, microwave, optics and lasers, microbiology and dermatology, and cancer therapy, with a h-index of 47 (Google) and 41 (Web of Science). He is a recipient of the International Society for Plasma Medicine Award (2010) and of the IEEE Nuclear and Plasma Science Society Merit Award (2015). He is a fellow of IEEE.