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The Role of Modeling in Developing New Plasma Technologies: Microelectronics to Plasma Medicine and Liquids¹

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Low temperature plasmas (LTPs) are the basis of many society benefiting technologies – and modeling has played important roles in aiding the development of those technologies. The non-equilibrium and chemically active nature of LTPs, and their interaction with their boundaries, requires broad inclusive modeling approaches which address electron kinetics at one extreme and plasma surface interactions at the other. In this talk, the past and future role of modeling in the development of new technologies will be discussed, with emphasis on one computational approach to this diversity, hybrid models. These models combine kinetic simulations with hydrodynamic techniques to capture the sometimes subtle roles of electron energy distributions, $f(\varepsilon)$, in the production and transport of reactive species - and it is control of $f(\varepsilon)$ that ultimately provides the desired fluxes of reactive species. Two examples of the use of modeling in the development of advanced technologies will be discussed -microelectronics fabrication and plasma medicine. In microelectronics fabrication, the fact that the plasmas are low pressure have provided opportunities to control of $f(\varepsilon)$ by choice, for example, of excitation method or frequency, opportunities not easily accessed at higher pressures. Models are continuing to provide insights to the means of controlling $f(\varepsilon)$ through use of active boundaries and pulsing. In plasma medicine, atmospheric pressure plasmas are applied to living tissue for therapy and sterilization, often in or through a liquid layer. Plasmas interact with tissue by generating fluxes of radicals, ions and photons onto cell surfaces, the intracellular generation of electric fields and the possible production of plasmas within biological fluids. The knowledge base of fundamental data in this field is sparse, thereby placing emphasis on the insights that modeling may provide in advancing the field.

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