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Tailoring charged particle distribution functions and chemical kinetics in non-thermal plasmas using multiple frequency excitation[1]

A. R. GIBSON, University of York, UK

Plasmas driven by multiple frequencies in the radio-frequency range are used extensively in low-pressure plasma processing applications. In recent years, much research has focussed on a particular class of multiple frequency waveform composed of two or more harmonics of a given fundamental frequency with specific phase shifts between them. These are often termed "tailored voltage waveforms". Numerous publications have identified favourable control of ion energy distribution functions (IEDFs), crucial for surface processing applications, in low-pressure plasmas driven by these waveforms. However, the application of tailored voltage waveforms for the optimisation of alternative applications of low-temperature plasmas is less commonly studied. In this contribution, tailored voltage waveforms are explored for the control of the electron energy distribution function (EEDF), key for reactive species production, in atmospheric pressure plasma jets using experimental measurements and numerical simulations. Experimental measurements using phase resolved optical emission spectroscopy (PROES) show that tailoring the shape of the driving voltage waveform through changing the fundamental frequency, number of harmonics, and phase shift between them, has a pronounced effect on the spatio-temporal plasma emission. One-dimensional numerical simulations for the same conditions show excellent agreement with PROES measurements and are used to demonstrate wide ranging control of the EEDF and reactive species production as the shape of the voltage waveform is changed.

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