Tailored Voltage Waveforms as a new RF excitation technique for unique plasma processing

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Since the pioneering work of the Bochum team on exciting plasmas with non-sinusoidal "Tailored" Voltage Waveforms and generating an Electrical Asymmetry Effect [1], the complexity and power of this technique has come into clearer focus. By decoupling the ion bombardment energy from the ion and radical flux at the surface, one can gain great insight into links between process parameters and outcomes. Going further, such asymmetric excitation allows us to gain access to internal constants (such as ion transport coefficients and reaction cross-sections) that are often hidden when exciting plasma symmetrically, allowing one to generate more accurate numerical models [2]. A specific subset of these waveforms, resembling sawtooths, has recently attracted particular attention ([3][4]), due to what has been dubbed the "slope asymmetry" effect, wherein they create an asymmetric ionization profile in the plasma that depends strongly on the electronegative character of the plasma ([5],[6]), as shown in figure 2 (from [5]). The location of the ionization peak is very sensitive to the electron heating mode (and thus linked to the electronegativity of the plasma). Such waveforms can therefore be used to determine the dominant heating mode under varying plasma conditions [7,8]. Finally, combining such unusual excitation with certain gas chemistries allows one to perform completely new processes, such as selective deposition, wherein a given plasma process occurs on one electrode but not the other.

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