Pulse Parameter Dependence of Reactive Species Generation in Global simulation of Atmospheric Argon/Oxygen Plasma.

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A global simulation of atmospheric Argon/Oxygen plasma was performed to investigate the dependence of reactive species density on microwave pulse power parameters. For constant time-average power and fixed plasma volume, the time-average density of each reactive species has negligible dependence on the pulse period but increases or decreases monotonically with the pulse width. During the pulse-on time, the electron temperature shows almost identical time evolution regardless of the power level while the electron density is proportional to the power, which suggests the boundary conditions determine the temperature evolution as in the case of static discharge. Forgiven average power, the average rate of each electron impact reaction, proportional to the electron density, becomes constant. Because the electron impact reaction is the dominant factor in the generation of reactive species, the discharges of the same pulse width have similar active species densities. A more realistic global simulation was carried out in consideration of the change of the plasma impedance within each pulse period, which affects the power coupling efficiency. An empirical model for the impedance of plasma jet and the observed evolution of the plasma length are used to apply the time-varying power coupling to the global simulation. The pulse operation reduces the impedance mismatch between the plasma and the electrode, resulting in higher energy transfer efficiency compared to the case of continuous wave.This advantage of pulse operation is expected to be applicable to many resonator type plasma devices.

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