Dynamics of Energetic Electrons at the Igniting Phase in A Pulsed CapacitivelyCoupled Plasma

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Compared with continuous-wave (cw) rf discharge, pulsed rfdischarge has shown its potential in improving the etch profile features andreducing the plasma induced damage, as it can provide high flexibility tocontrol important plasma parameters such as the Electronic Energy DistributionFunction (EEDF) and the electron density by adjusting the pulse frequency, theduty cycle, etc. Therefore it has attracted increasing academic and industrialinterest in recent years.

In a pulse modulated rfcapacitive discharge operated in argon, it is well known that the electron temperature or emission intensityexhibits a sharp peak at very beginning of the active glow and then slowlydeclines to a stable value. People generally attribute the sharp peak to thefact that at the igniting phase the electron density is very low, the rf poweris coupled to the few electron, leading to high averaged electron energy. Inthis work, the spatio-temporal evolution of electron excitation rate in a pulsedcapacitive discharge operated in Ar was studied by phase-resolved opticalemission spectroscopy. It is found that the electronic excitation dynamic atthe pulse-ignition phase exhibits different behavior from that in stable-state discharge.During the first tens of rf cycles after the pulse ignition, the plasma isfound to operate in DA (drift and ambipolar) mode. This is because at theigniting phase the electron density is low, similar to that in electronegativecapacitive discharge, a high electric field must be built up inside bulk regionto push electrons, sustaining a certain current flowing through the bulk region.With the advance of time, the discharge gradually turns into mode as theelectron density rises. Also, we investigated effects of external parameters (therf voltage, the working pressure, the duration of after-glow, etc.) on the DA-? mode transition during the active-glow period.

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