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Generation of highly-controllable versatile microwave plasma using dual resonant-cavity[1]

HIDEO SUGAI, Chubu University

In near future, conventional magnetron sources are being to be replaced by digital solid-state sources at microwave frequency, which enables us to control frequency, phase, and amplitude. Based on this state-of-the-art microwave technology, we succeeded in developing a novel plasma using two resonant cavities. One is a rectangular cavity (mode:m =1 at resonant frequency f_1) which generates a center-high plasma. The other is a toroidal cavity (m =3 at f_3) which generates an edge-high plasma. Injecting the microwave power (2400 - 2500 MHz) into the dual resonant-cavity, we can generate a radially uniform plasma by adjusting a ratio of the rectangular cavity power at f_1 to the toroidal cavity power at f_3. In addition, an azimuthally uniform plasma can be generated by rotating the resonant fields inside the two cavities. In this rotation system, a pair of microwave powers modulated in amplitude at low frequency (0.1 - 1000 Hz) is injected into each cavity. Microwave powers are supplied from dual input ports orthogonally placed on each cavity, with the modulation phase shifted by 90. The simulations and experiments showed that the microwave cavity field and the plasma optical emission pattern are rotated at the modulation frequency. The microwave plasma of 40 cm in diameter was generated in a wide range of argon pressure (0.1- 20 Torr) with a total microwave power <3 kW. Additional experiments of methane discharge will be also reported in the conference in view of applications of this novel microwave plasma to CVD process of graphene and diamond film.

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