Controlling of Spokes and Breathing Oscillations in Partially-Ionized EXB plasmas

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Spoke mode and breathing mode are main modes of low frequency oscillations (from a few kHz to a few tens kHz) commonly observed in Hall thrusters, Penning discharges, helicon plasma sources etc. In addition, spoke oscillations of higher frequency (~ 100 kHz) are also observed in magnetron discharges. Since spoke and breathing oscillations are most powerful modes, which can be up to 100% of the applied power (e.g. breathing oscillations in Hall thrusters), they may have profound effect on operation of these ExB discharges. In this talk, various effects of input parameters, including magnetic field, gas pressure, gas type, wall materials and discharge geometry on both modes of oscillations are analyzed to identify dominant mechanisms of these oscillations using frequency scaling relationships for several instabilities predicted in theoretical studies [1]. We will also discuss results on suppression and driving of these oscillations. Using segmented anode and a feedback control, we demonstrated the suppression of rotating spoke in a cylindrical Hall thruster (CHT) [2]. The same segmented anode approach can also be used to drive this mode by applying a wave voltage between to the anode segments with successive phase shifts. For the CHT, driving at the natural spoke frequency in the E×B direction was shown to enhance the coherence of the spoke, while driving at other frequencies generally suppresses the coherence of the spoke [3]. A qualitatively similar behavior was observed with driving breathing oscillations [4]. Responses of breathing oscillations to the driving signal will be discussed.

References:

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