Theoretical study on plasma pattern formation and propagation during air breakdown by three intersecting microwave beams

Qianhong Zhou, Zhiwei Dong, Wei Yang

Institute of Applied Physics and Computational Mathematics, Beijing, China

Air breakdown by three intersecting high power microwave (HPM) beams is investigated by numerical solution of fluid-based plasmas equations coupled with the Maxwell equations. For three coherently intersecting HPM beams, interference-field maxima (form a triangular lattice) and minima are created in the intersecting region. The collisional cascade breakdown occurs only if the initial free electron appears or arrives in the vicinity of field maxima, where the free electron can be accelerated. A ball-like plasmoid grows around a field maximum (if there are seed electrons) until its density becomes large enough to diffract the incident field. When the plasma density is larger enough, it scatters the three waves and redistributes the interference pattern. Diffusion and ionization in the closest maximum field leads to the formation of new plasmoids. As time increases, the new plasmoids will form regular patterns and the plasma region enlarges.

1. Introduction

Microwave air breakdown has been extensively investigated since the 1940s. Previously, microwave air breakdown induced by single high power microwave (HPM) beam has been widely investigated[1-5]. However, relatively few studies existed on microwave air breakdown by intersecting microwave beams. Actually, two or more HPM beams are needed to satisfy the power requirement of applications. For example, many HPM beams are sent to the atmosphere with the help of ground-based antennas, in the beam crossing region, where the electric field is particularly large, a gas discharge is set up, i.e. an artificial ionized layer is formed.

In order to successfully use the air breakdown by crossing beams, it is necessary to have a clear understanding of which processes are involved and to what extent. Recently, we have studied microwave air breakdown in the region of two intersecting waves[6,7]. The plasma pattern formation and propagation by two waves is different from that by single wave.

In this paper, Air breakdown by three intersecting HPM beams is investigated by numerical solution of fluid-based plasmas equations coupled with the Maxwell equations. The detailed plasma pattern formation and propagation is investigated for different incident angles.

2. References

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