Analysis of the multipactor effect in a parallel plate waveguide with multiple modulations *

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Abstract

Multipactor is an RF breakdown that may occur in the high power microwave devices working under the vacuum condition. A particular scenario where the multipactor appears is inside a parallel plate waveguide. Between these two plates, it exists an electric field with an electric potential difference which produces the electron movement. Applying the Newton equations to this environment, it is possible to find out the position and the speed of the particle at any time.

$$\overrightarrow{F} = m \cdot \vec{a} = -e \cdot \overrightarrow{E_{RF}}. \tag{1}$$

$$\overrightarrow{E_{RF}} = \frac{V}{d} \cdot \cos(w \cdot t + \theta) \tag{2}$$

When an electric field is applied to the electron inside this structure, this electron tends to impact with the plate. One of the objectives is to find out the speed that the electron achieves when the impact is produced. Applying this speed value to the kinetic energy equation, it is possible to model the electron impact in the plate. The consequence of the crash is the appearance of new electrons. Some of them will impact with the opposite plate and so on [1]. Simulating these impacts, we determine when the multipactor effect appears.

The differential equation (1) can be numerically solved using Runge-Kutta's method. The key idea is to determine the impact time for the electron subject to the field given by equation (2). However, when multiple modulations are applied, the difficulty of resolving the equation increases greatly. The purpose of this study is to analyse if multipactor effects appears in this particular environment under different field conditions (multiple carriers and different modulations).

Keywords: Bouncing ball model, video analysis, Multipactor effect, parallel plate waveguide, secondary electron emission.

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