Characterization of Single Surface Multipactor Discharge in the Frequency Domain*

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This work presents the characterization of the single surface multipactor discharge [1] in the frequency domain with rf electric fields of single or two carrier frequencies. We employ a multiparticle Monte Carlo (MC) simulation scheme [2] in one dimension with exact adaptive time steps to obtain the temporal profiles of the normal electric field to the dielectric surface [3]. We perform Discrete Fourier Transform (DFT) on the temporal profile and obtain the amplitude spectrum of the normal electric fields in the ac saturation state. The normal electric field corresponds to the multipactor strength in the system.

For single frequency rf operation, we observe [4] spectral peaks in the amplitude spectrum of the normal electric field, E_x, at the even harmonics of the fundamental rf frequency (Fig. 1a). We express the heights of the spectral peaks as functions of their respective harmonic numbers and the rf amplitude. We find empirical expressions to describe the temporal profile of the normal electric field in terms of the DFT peaks (Fig. 1b).

For two-frequency rf operation, spectral peaks are observed at various frequencies of intermodulation products [4] of the two carrier frequencies (Fig. 1c). The temporal profile of the normal electric field can be approximated by an empirical equation in terms of these most prominent spectral peaks (Fig. 1d).

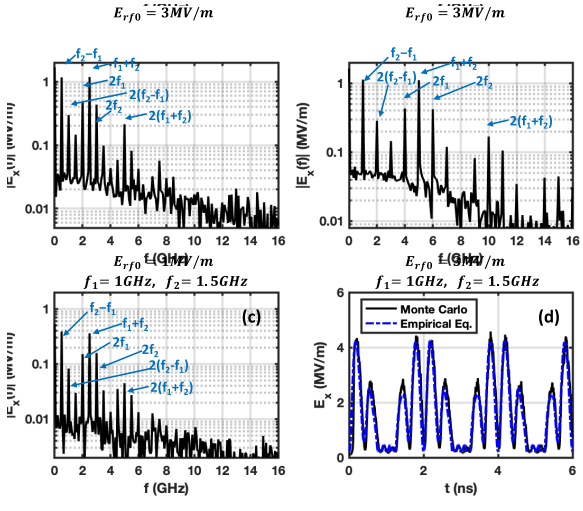

Figure 1 – Top row: (a) Amplitude spectrum of the normal electric field in the ac saturation state for single carrier rf operation with rf amplitude, $E_{rf0} = 3MV/m$ and frequency $f_{rf} = 1GHz$, (b) Temporal profiles of the normal electric field E_x in the ac saturation state for the rf configuration in (a) obtained from the MC simulation (black solid lines) and the proposed empirical equation (blue dashed lines). Bottom row: (c-d) Same plots as (a-b) for two-frequency rf operation with rf amplitude $E_{rf0} = 3MV/m$ and frequencies $f_1 = 1GHz$, $f_2 = 1.5GHz$.

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References

[1] R. A. Kishek and Y. Y. Lau, Phys. Rev. Lett. **80**, 193 (1998).

[2] A. Iqbal, J. Verboncoeur, and P. Zhang, Phys. Plasmas **26**, 024503 (2019).

[3] A. Iqbal, Patrick Y. Wong, D.-Q. Wen, Shu Lin, J. Verboncoeur, and P. Zhang, Phys. Rev. E **102**, 043201 (2020).

[4] A. Iqbal, P. Y. Wong, J. P. Verboncoeur, and P. Zhang, IEEE Trans. Plasma Sci. **48**, 1950 (2020).