Multipactor discharge simulated via a Vlasov-Poisson numerical model*

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Multipactor discharge occurs within or around structures operating in vacuum under oscillatory RF fields. The multipactor phenomenon leads to rapid charge growth, which is detrimental to microwave device performance through power reduction, reflections, heating, and component degradation. Primarily studied by the accelerator and space communities, multipactor has been simulated mainly via PIC Monte Carlo models. An alternate simulation method has been developed using the Vlasov-Poisson equation that permits the complete capture of the electron distribution within the simulated phase-space. Thus, all qualities of the phase-space, such as electron energy distributions, average impact energy, and density profiles, are resolved at any given time. This alternate method was benchmarked against commercial software and experimental data.

In this contribution, electron dynamics are simulated using the Koren flux-limited scheme with two-surface multipactor incorporated via an energy-dependent secondary electron yield at the appropriate boundaries. Backscattered, rediffused, and true secondary electrons are all incorporated using a combination of both elastic and inelastic energy distributions. The inclusion of the Poisson equation allows for space-charge effects to be accounted for self-consistently within the region excited by the applied RF field. The Vlasov-Poisson equation can simulate multipactor from the onset and well into the saturation regime without any change in computational requirements as multipactor develops, as is usually the case for particle codes. For any given material, the differences in saturation across various orders of multipactor can be observed by performing a parametric sweep of frequency and RF. The addition of space-charge effects also allows the study of electric-field distributions over time as multipactor occurs. A range of electric-field rise times were also simulated representing more realistic propagating RF waves and to determine its effects on multipactor development. Electric-field rise times are difficult for PIC codes to study as the peak number of particles is unknown beforehand requiring increased memory overhead. These formulas could be extended to treat complex geometries and multicarrier excitations. Details of the simulation scheme and results obtained will be presented, and implications for multipactor analysis discussed.

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