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FROM MULTIPACTOR TO IONIZATION BREAKDOWN: REVIEW AND RECENT ADVANCES*

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Multipactor and its transition to gaseous ionization breakdown remain one of the most significant limitations in RF device operation, particularly at high power. Nonlinear effects can couple multiple carrier frequencies, cause instabilities and dispersion, and result in temporary failure as well as permanent damage. These phenomena are relevant to conducting and dielectric surfaces, in devices ranging from communications to high power microwave sources, to accelerators and even high gradient microwave circuits and devices.

In this ongoing work, carried out over the past decade, we examine the process of initial multipactor growth, surface heating and gas desorption, and subsequent evolution to ionization breakdown. We look at a variety of mitigation schemes, from spatio-temporal signal modulation to surface morphology and materials properties.

This work is part of a larger effort which includes development of standardized platforms in planar, coaxial, and stripline configurations, with both computational and experimental analogs to enable validation and develop analytic and predictive capability integrated with well-tested experiments. The test cells enable study of multipactor susceptibility and transition to ionization breakdown, as well as novel material, geometric, and electrical mitigation schemes in isolation or as a system. Test cell designs allow variations in gap spacing, driving frequency, waveform shape, ambient and desorbed gas, surface morphology, and many other key parameters. The cells will motivate integration and development of novel diagnostics, such as direct multipactor electron detection, optical/VUV emission spectroscopy, and X-ray imaging, at ns timescales and sub-mm- spatial scales.

The test cells and corresponding models will be published in detail and made available to the community as standard reference platforms on which repeatable basic physics results can be studied, validated, benchmarked, and openly published.

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