Experimental study of microwave plasma breakdown in microstrip devices for power limiting applications

A. Simon[1], R. Pascaud[1], T. Callegari[2], L. Liard[2], O. Pascal[2]

[1]*ISAE-SUPAERO, Université de Toulouse, Toulouse, France*
[2]*Université de Toulouse; UPS, INPT, CNRS; LAPLACE (Laboratoire Plasma et Conversion d'Energie); 118 Route de Narbonne, F-31062 Toulouse, France*

This poster presents microstrip devices including self-power-limiting capability thanks to plasma microdischarge. A classic DC microhollow cathode discharge is therefore ignited under the ground plane of the microstrip device. When the microwave power reaches a tunable threshold, the plasma expands to the upper part of the microstrip circuit, which causes a major change in its behaviour. The upper part of the plasma is then controlled both by microwave and DC power. Different microstrip devices are experimentally characterized with their microwave parameters to get insight on the role of the electromagnetic field on the plasma extension. All exhibits the self-power-limiting capability, at different levels depending on the intensity of the microwave electromagnetic field at the plasma location.

1. Plasma as microwave protection element

Plasmas have been used for power protection in high frequency communications for a long time, for example in T/R tubes [1]. The recent explosion of microwave communication devices of smaller power range has triggered a need for protection on microstrip devices.

Plasma presents two main advantages in this purpose: it handles a microwave power higher than any other existing solution (diode, varicap, MEM…) and insertion losses on the device can remain extremely low.

2. Plasma microdischarges in microstrip devices

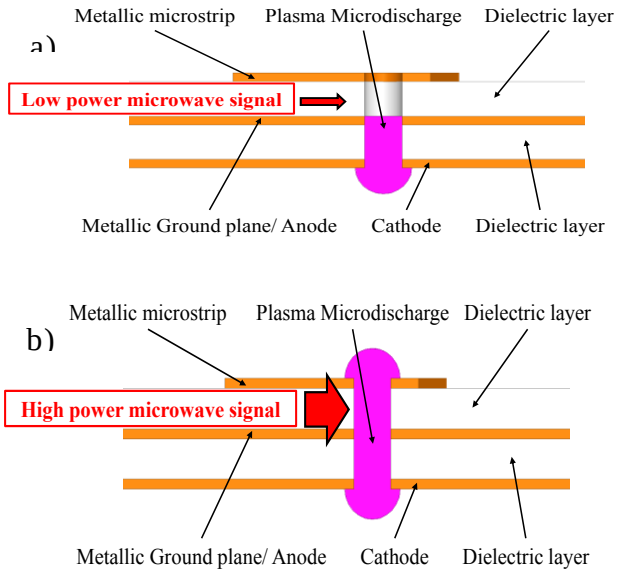

Fig 1: The "off" (a) and "on" (b) state of the microstrip device with self-power-limiting capabilities

The ignition of a Micro Hollow Cathode Discharge (MHCD) with a typical breakdown of 300 V under the ground plane (Figure 1a) allows the generation of plasma above the microstrip line at very low power threshold, typically 1 Watt (Figure 1b) [2].

3. Study of microwave plasma breakdown

In this poster, we present an experimental work that aim at evaluating the characteristics of the plasma generated on the upper part by microwave power.

Each microstrip device is inserted in a vacuum chamber. Pressure in argon varies from 1 to 100 Torr. The plasma is ignited in a cylindrical aperture whose diameter depends on the pressure work. Different microstrip circuits are characterized with S parameters and power balance to understand the role of the electromagnetic field on the plasma formation and stability. Self-power-limiting capability is demonstrated, and the trigger level can be controlled. Depending on the circuit design, plasma effect of the microwave power can be either absorptive or reflective.

4. References

[1] A. Kraszewski, "Microwave Gas Discharge Devices", lliffe Books Ltd. (1967).

[2] R. Pascaud *et al*., Electronics Letters, vol. 51, no. 14, pp. 1090-1092, (2015).