MEASUREMENT OF THE BREAKDOWN VOLTAGE ON THE SURFACE OF THE ALUMINIZED POLYIMIDE FILM TREATED BY PLASMA IMMERSION ION IMPLANTATION

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1. Introduction

Passive thermal control systems used in satellites utilize aluminized polyimide film (Kapton™) as the outermost layer. In contact with the harsh space environment, polyimide film suffers multiple types of degradation. At Low Earth Orbit (LEO) (up to 1,000 km) a significant degradation of the Kapton is the electrostatic discharge (ESD) that may occur due to the charge accumulation on the surface of the film. The main source of charge build-up is the low dense plasma present at LEO. So, it is desirable to improve the dielectric breakdown voltage on the surface of the Kapton in order to reduce the probability of ESD occurrence which, in its turn, could keep the internal parts and components of the satellite safer against electrical damages.

2. Experimental

Kapton film type HN (1 mil in thickness) has been treated by plasma immersion ion implantation of nitrogen (PIII) [1]. The treated film and the pristine aluminized Kapton, as well as the untreated Kapton film without aluminum have had their surface breakdown voltage measured at several pressure conditions. The distances between the two electrodes set up to apply the voltage on the film surface were kept approximately the same and the small variation in the electrodes distance from one set of measures to another was considered by expressing the breakdown voltage as a function of the product of the pressure (p) by the electrodes distance (d). So, the curves obtained can be considered as Paschen curves.

3. Results and Discussions

The curves of breakdown voltage as function of the product pd are shown in Figure 1 for: (a) air, when no film was present between the electrodes; (b) film of pristine Kapton without aluminum; (c) film of pristine aluminized Kapton, and (d) film of aluminized Kapton treated by PIII. As one can see the surface breakdown voltage of the aluminized Kapton treated by PIII in the region of low pressure (pd < 10^{-3} Torr.cm) is higher than the breakdown voltage of the pristine aluminized Kapton and in these cases the breakdown voltages seems to be approximately constant which may allow extrapolating the values to the pressures found at LEO which can be as low as 10^{-11} Torr. This result indicates that the treatment of Kapton by PIII of nitrogen can be advantageous to reduce the risk of ESD phenomenon in the film of Kapton used in LEO.

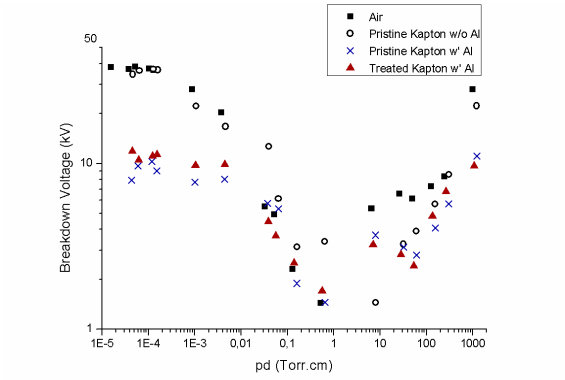

Fig. 1. *Breakdown voltage of the air, pristine Kapton without aluminum, pristine aluminized Kapton and aluminized Kapton treated by PIII of nitrogen as function of the product of the pressure (p) by the distance (d) between the two electrodes used to apply the voltage on the surface of the film*

4. References

[1] MARCONDES, André Ricardo; UEDA, Mario; ROSSI, José Oswaldo. Effect of nitrogen plasma immersion ion implantation on surface electrical breakdown strength of the aluminized polyimide. **Revista Brasileira de Aplicações de Vácuo**, v. 36, n. 3, p. 122-130, 2018.

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