State of the art on the use of Conductive Fabrics for Lightning Protection

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Abstract—In this paper we present a review on the research and developments of lightning protection based on conductive fabrics. Efforts to understand, model, test, and design materials based on conductive fabrics able to withstand intense current pulses, developed in the last decade, are discussed. Research work starting from conductive-fabrics electrical and thermal modeling to experimental results on new composites will be reviewed.

Keywords- conductive fabrics; conductive textiles; lightning strokes; lightning; lightning protection; woven fabric.

I. INTRODUCTION

Conductive fabric is a versatile material used in different applications including electromagnetic shielding, sensors, and wearables. Due to its capability to conduct intense current pulses and its low weight, another application that has drawn the attention lately is lightning strike protection. Lightweight components for lightning protection are required in oil tanks, aircrafts, portable shelters, and wind turbines, where conductive films and composite materials are being commonly used. In this talk, a review on the research findings and recent applications of conductive textiles for lightning protection is presented.

II. EXPERIMENTAL TESTS

Impulse experimental tests have shown that conductive fabrics can endure high current impulses. Different effects are obtained depending on the current level, fabric layers, weave pattern, and conductive material. These effects include melting, vaporization, and bursts at hot spots [1]. Based on a series of experimental tests with 10/350 µs current impulses, Roman et al. reported 2.5 kA/cm as the maximum lightning current density for one layer of rip-stop textile [2].

Some recent applications include the use of electrically and thermally conductive structural fabric to provide direct lightning strike protection on some areas of aircrafts and also electromagnetic shielding [3]. These characteristics are obtained with fibre and metallic-wire hybrid fabrics and interlaminar conductive nonwovens in carbon-fiber-reinforced-polymer laminates.

III. ELECTRO-THERMAL MODELING

Electrical models have been used to estimate the effects of intense current impulses on conductive fabrics. Based on experimental tests, the fabric resistance can be calculated and used to estimate the potential rise due to the impulse current [1]. Other studies look for the capacity to handle high impulsive currents. Scratches perpendicular to the current flow, initially denominated as "striation", were observed in impulsive tests on different kinds of conductive fabrics. These scratches, produced by the conductive layer evaporation, reveals that thermal dissipation and phase change were produced at hot spots, generating a non-linear behavior from the electrical point of view.

Striation on conductive woven fabrics is explained on [4] using an electrical equivalent circuit that considers yarns' contact resistance and its specific action required to reach melting, evaporation, and burst limits.

IV. CONCLUSION

Conductive fabrics are a promising component of future lightweight lightning protection systems that can be easily integrated to structural components. Experimental tests and theoretical and numerical models show that conductive fabrics can endure high density current levels; however, several conductive layers or large areas are required to withstand a direct lightning strike.

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