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3D-Printing of Waveguide Terminations: Effect of Material Shape and Structuring on Their Characteristics

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Abstract : Matched termination is an important part of the passive waveguide components. It is typically used at the end of a waveguide transmission line to prevent reflections and improve signal quality. Waveguide terminations (loads) are commonly used in microwave and RF applications. In traditional microwave architectures, usually, waveguide termination consists of a standard rectangular waveguide made by a lossy resistive material, and ended by shorting metallic plate. These types of terminations are used, to dissipate the energy as heat. However, these terminations may increase the size and the weight of the overall system. New alternative solution consists in developing terminations based on 3D-printing of materials. Designing such terminations is very challenging since it should meet the requirements imposed by the system. These requirements include many parameters such as the absorption, the power handling capability in addition to the cost, the size and the weight that have to be minimized. 3D-printing is a shaping process that enables the production of complex geometries. It allows to find best compromise between requirements. In this paper, a comparison study has been made between different existing and new shapes of waveguide terminations. Indeed, 3D printing of absorbers makes it possible to study not only standard shapes (wedge, pyramid, tongue) but also more complex topologies such as exponential ones. These shapes have been designed and simulated using CST MWS®. The loads have been printed using the carbon-filled PolyLactic Acid, conductive PLA from ProtoPasta. Since the terminations has been characterized in the X-band (from 8GHz to 12GHz), the rectangular waveguide standard WR-90 has been selected. The classical wedge shape has been used as a reference. First, all loads have been simulated with the same length and two parameters have been compared: the absorption level (level of |S11|) and the dissipated power density. This study shows that the concave exponential pyramidal shape has the better absorption level and the convex exponential pyramidal shape has the better dissipated power density level. These two loads have been printed in order to measure their properties. A good agreement between the simulated and measured reflection coefficient has been obtained. Furthermore, a study of material structuring based on the honeycomb hexagonal structure has been investigated in order to vary the effective properties. In the final paper, the detailed methodology and the simulated and measured results will be presented in order to show how 3D-printing can allow controlling mass, weight, absorption level and power behaviour.

Keywords : additive manufacturing, electromagnetic composite materials, microwave measurements, passive components, power handling capacity (PHC), 3D-printing
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