Absorbants hyperfréquences multi-matériaux par impression 3D

Multi-materials 3D printed microwave absorbers

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1. Context

Potential applications of electromagnetic absorbers strongly increased over the past few years. Radar absorbing materials were mainly used for stealth applications in the past but are now also integrated in industrial processes (electromagnetic compatibility in RF systems, antennas...). Moreover, the strong development of wireless technologies has led to an increase in the human exposure to electromagnetic waves. This fact give rise to new public health issues and house protection against electromagnetic radiations is thus a pretty hot topic. Potential applications of radar absorbers are nowadays numerous and new technologies have thus to be developed to answer to these growing needs.

Usually, microwave absorbers are made of an elastomeric matrix filled with lossy particles (for example carbonyl iron). These polymer composites are molded and machined to fabricate thin plate (a few mm thick). For this fabrication process, it is quite complex to realize multi-materials absorbers, and thus, to explore their potential.

Fused Deposition Modeling, an Additive Technology that consists in fabricating an object layer-by-layer, makes it possible to fabricate multi-layers multi-materials objects. Moreover, these layers can be structured in the form of periodic single elements (honeycomb...). This technique is low cost and leads to a fast and easy development process. However, there are some limitations that have to be addressed such as the control of dimensions and fabrication time.

2. Objectives

This PhD project aims at developing new multi-materials multi-layers absorbing screens by using 3D printing techniques. The fabrication process is based on the use of Fused Deposition Modeling (FDM) that consists in fabricating an object layer-by-layer (thickness of layers between 50 and 200 µm). This low-cost technique makes it possible to print different polymers including polymer composites whose electromagnetic properties can be compatible with absorption applications. Nowadays, 3D printers allow printing several materials in a single step, and thus, paves the way to a new class of multi-materials microwave absorbers.

Recent works at Lab-STICC demonstrated that it is possible to fabricate honeycomb microwave absorbers (HCA) with this technique. In real applications (aircrafts), these HCA are covered with a dielectric layer that ensures the required seal. Multi-materials printing could allow fabricating these structures in a single step. Preliminary simulations showed the interest of a global optimization of this bilayer structured absorber. Fig. 1 thus compares the response of a bilayer constituted of two homogeneous layers of PLA (blue) and conductive PLA (black) and that of a bilayer constituted of a homogeneous layer of PLA that covers a HCA layer of conductive PLA. The optimized homogeneous bilayer presents in simulation an absorption bandwidth (reflection coefficient < -10 dB) of 6.6 GHz for a total thickness of 4.7 mm. The bilayer that includes the HCA made of conductive PLA presents an absorption bandwidth of 9.55 GHz for a slightly higher thickness of 6.4 mm. This preliminary results
demonstrate the interest of multi-materials multi-layers structured absorbers that can be easily fabricated in a single step by 3D printing technique.

Fig. 1. Comparison of reflection coefficients of a homogeneous bilayer absorber (green) and of a bilayer that includes HCA with a homogeneous dielectric layer (red) between 2 and 18 GHz.