3D-Printed Multi-Material Multilayer Wideband Microwave Absorber

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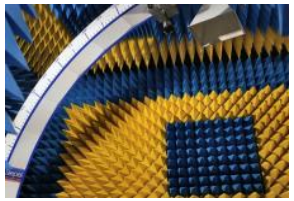
STATUS QUO

Uses of EM Wave Absorbers



- ✓ Various constraints depending on the environment → different solutions with distinct drawbacks: RAM absorbers, pyramids, honeycombs, ML absorbers, metasurfaces, …
  - ➢ Need for absorbers combining good absorption, wide bandwidth, thin shape, lightweight, ease of fabrication

NEW INSIGHTS

Filament Manufacturing → EM Characterization → ML Optimization → 3D Printing and Measure

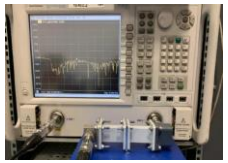
3D-printed Multilayer Multi-material Absorber

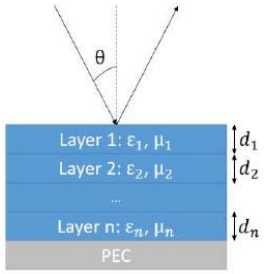
- ✓ Multilayer structure
  - ➢ Wide bandwidth and good absorption level
  - ➢ Optimization algorithm to find thin structures
- ✓ 3D printing
  - ➢ Fast prototyping for complex 3D structures
  - ➢ Possibility to print multi-material objects in a single process
  - ➢ Need for filaments with absorption properties

DESCRIPTION

- ✓ Filaments requirements for multi-material absorber
  - ➢ Mix of dielectric-loss, magnetic-loss, and low-loss filaments to maximize impedance matching
  - ➢ Fabrication of magnetic-loss filaments: materials mixing, cryo-grinding, extrusion

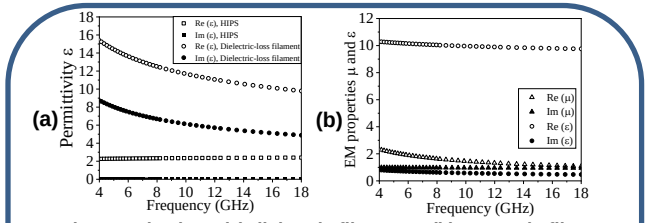
- ✓ Optimization of the 3D printing process for characterization
  - ➢ Calibration for printing stability and minimizing induced porosity (thickness layer, filling pattern, printing speed, temperature, …)
  - ➢ EM characterization (ε and μ) with transmission line method between 4-18 GHz



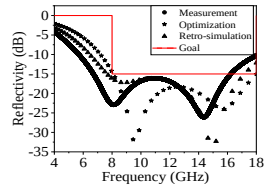


- ✓ Optimization of the multilayer absorber
  - ➢ Based on Chew recursive formula for ML structures
  - ➢ GA for global optimization
  - ➢ Modification to adapt to the accuracy of the 3D printer and consider constraints (complexity, minimum layer thickness, …)

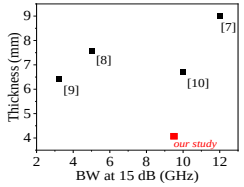
QUANTITATIVE IMPACT



EM characterization : (a) dielectric filaments, (b) magnetic filament



Optimization of the ML structures in the X-Ku bands



Comparison of bandwidth and thickness for absorbers

PROPOSED CONCEPT GOALS

- ✓ Characteristics of the 3D-printed absorber
  - ➢ Large bandwidth at 15 dB: 9.5 GHz (from 6.7 GHz to 16.2 GHz)
  - ➢ Thin: Thickness of 4.07 mm
  - ➢ Lightweight: Area density of 5.3 kg/m²
- ✓ Outlook
  - ➢ Optimization of the fabrication process (accuracy, printing speed, thickness control)
  - ➢ Improvement on the absorbing filaments (flexibility, losses, test in harsh conditions)