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Topology Optimisation and the All-Dielectric Microwave Absorber.

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1 Extended Abstract

Additive manufacturing (AM) has indisputably been a disruptive technology across many disciplines, but it can often be viewed primarily as a substitute for traditional manufacturing processes [1]. Our goal is to develop a general design methodology that embraces the AM ideology, opening the prospect of creating unique multi-material microstructures with novel capabilities. Such aspirations required us to explore alternative design methods and materials which can concurrently balance manufacturing sensitivities with the utility of design. Naturally, a major issue with all-dielectric composition is their ability to obtain a secure diamagnetic response of the constituents [2]. Resolution of this issue means examining high-index sub-wavelength dielectric particles which have been shown to support robust magnetic and electric dipolar resonance across the microwave spectrum [3]. Here, we offer an alternative approach by advocating the use of a high-permittivity inclusion, water, facilitated within a low-index dielectric matrix. Water is a natural choice providing the required functionally with additional flexibility that is currently not substitutable in an AM context [4]. Through the deliberate distribution of the fluid within the structure directed by a topology optimisation [5] inspired routine, we show that it is possible to induce user defined electric and magnetic dipole behaviour [6].

In this paper, we illustrate the effectiveness of our all-dielectric design methodology by creating a perfect wideband absorber through dynamically depositing water of different graduate sizes and locations within a 3d printed host structure that can create multiple overlapping enhanced electric and magnetic resonances. These modulations are in-phase resulting in an impedance matched material that when coupled with the highly dispersive water can efficiently couple impinging EM energy into the device without reflection at the interface. Thus ensuring complete absorption of the EM energy across a wide bandwidth.

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