SELF-ASSEMBLED METAMATERIAL STRUCTURE WITH PHOTONIC BANDGAP

The invention is a new self-assembled 2D or 3D structure that is isotropic and has complete photonic bandgap. It proposes a cost-effective method to manufacture this high performing structure at the industrial scale. This invention has potential applications in the optical industry, in manufacturing resistant dyes and could be used as a wave isolant.

Context

Photonic structures with bandgaps are characterized by frequency bands at which electromagnetic waves cannot propagate and others bands at which waves can propagate. The specific features of photonic bandgap structures lean on the periodicity of their dielectric properties variations and/or their structural arrangement.

Natural photonic bandgaps *i.e.* opal, do not have a complete band gap which limits their applications. Artificial bandgap structures (2D, 3D) are difficult to manufacture in large quantity and the manufacturing process is slow. No self-assembly mechanism is efficient enough to build a high performing metamaterial.

There is thus a need for 2D or 3D photonic bandgap structures that are easy to manufacture, characterized by variable dimensions (micron to meter) and that respect the constraints related to their structural organization to obtain 1 or several complete photonic bandgaps.

Invention description

The proposed invention is a new structure of a metamaterial with complete photonic bandgap and a simplified cost effective manufacturing process of 2D and 3D photonic structures with enhanced performances.

The invention uses a solid structure to prepare the solid photonic structure that has one or more complete photonic band gaps for a wavelength range. Its structure is composed by 2D or 3D dry foam relatively monodisperse with edge of board covered by material. The structure can be ordered (crystal, polycrystal), disordered (hyperuniform metamaterial, self-uniform or without any precise organization) and has a bandgap for polarized waves.

The manufacturing process of the structure comprises 2 or 3 steps. First, a dry solid foam ("open-cell" type) is made, then coated with similar material or another material with controlled thickness. The material can then be replaced by another material with higher refractive index (method mould-to-mould).

The proposed structure can be self-assembled. This is a method that takes advantages of the physical interactions to obtain a metamaterial characterized by original properties. This method does not have the disadvantages of others methods such as 3D printing or lithography.

Added value

A photonic metamaterial with a disordered structure with large band gaps is a major evolution for the existing collection of photonic metamaterials, even more so if it is self-assembled. Indeed, it is easier to scale the manufacturing process up to the industrial scale. The only self-assembled photonic materials are crystals that are very sensitive to defaults and are not isotropic which limit their applications.

This invention thus provides a structure for a metamaterial that:
- is self-assembled.
- has a complete photonic band gap.
- is potentially isotropic.

Potential market

Potential applications are wave guiding or quantum trap in the optical business. The invention method can also be used to manufacture non-iridescent resistant dyes and new photonic materials adapted to acoustic waves (wave isolant).

Intellectual property

Ongoing patent application in France (non-published)

Keywords

Metamaterial; Photonic structures; Complete bandgaps; Dry foam; Honeycomb structures; Wavelengths

Technology domain

Optic; Photonic materials

Technology transfer contact

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