2023 Conference on Lasers and Electro-Optics Europe & European Quantum Electronics Conference (CLEO/Europe-EQEC) | 979-8-3503-4599-5/23/$31.00 ©2023 IEEE | DOI: 10.1109/CLEO/EUROPE-EQEC57999.2023.10232300

Fabrication and analysis of 3D asymmetric pillar-shaped metamaterial for low terahertz (THz) application

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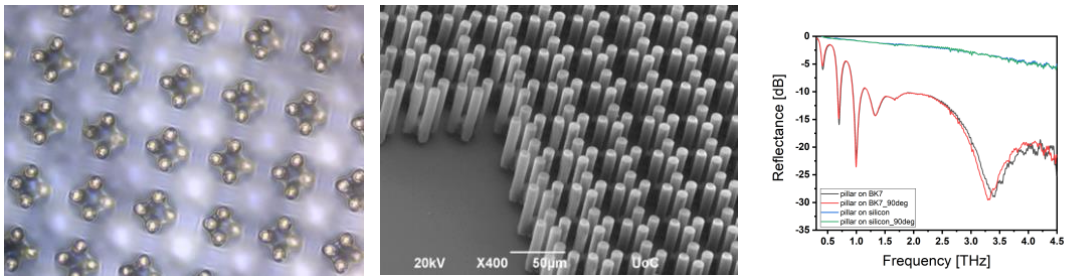
Artificial designed materials, known as metamaterials have changed the way we understand nature and overcome almost any limitation. Electromagnetic metamaterials exhibit high potentional for many future applications in many fields. Fabrication of 3D optical metamaterials, which would enable the use of their full potential, remains challenging due to the limitations of conventional manufacturing techniques. An approach suitable to overcome this challenge is multi-photon lithography (MPL) [1], which is a true 3D printing technique with high resolution down to sub-100 nm.

In this work, the high potential of using MPL for metamaterial research is further underlined by demonstrating a procedure to process metamaterials operating at low THz frequency (1-10 THz) and generate novel devices as perfect absorbers and electromagnetic waves attenuators. In these frequencies there is no natural element that can interact with electromagnetic fields, making the development of metamaterial devices even more important. Simulation by Finite Differential Time Domain (FDTD) [2], method were done to design the materials' geometry giving the optimal dimensions and properties for the structure. As a photosensitive material for the MPL an organic – inorganic photopolymer SZ2080™ [3] was used. After MPL processing, the structures were further processed using selective electroless plating to cover the polymer with silver via chemical procedure [4], so the spectral characterization (absorbance, transmittance, reflectance) can be done at THz frequencies due to the high conductivity that Ag atoms can provide.



(a) (b) (c)

Fig. 1 (a) Image taken from optical microscope, highlighting the selective process of Ag electroless spattering, fabricated on Silicon substrate, (b) SEM image of the fabricated metamaterial, (c) Reflectance measurements.

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