Switchable holograms & nanoscopic zoom lenses: Integrated multifunctional meta-surfaces (APNPCs) enable ultra-fast dynamic beam steering

TLB
Technologie-Lizenz-Büro
der Baden-Württembergischen
Hochschulen GmbH

Nanoscopic zoomlenses, dynamic beam steering and holograms – thanks to an inventive combination of metamaterial on top of a phase change material, all this features can be implemented. Within ultra-short intervals, light beams can be deflected within nano-scales.

- Combination of several meta-surface functionalities within a robust layer system
- Reversible optical and electrical switching of multiple optical functionalities
- Ultra-fast focusing and variable beam control in one optical element
- Individual adaptation to the application by choosing material and structure

Application

This concept stands for a new generation of robust optical elements such as nanoscopic variofocal lenses and switchable holograms. An even faster beam control could also help further improve high-performance LIDAR systems.

Contact

Dr. Hans-Jürgen Eisler
Technologie-Lizenz-Büro (TLB)
Ettlinger Straße 25
76137 Karlsruhe
Phone + 49 721 / 790 040
eisler@tlb.de | www.tlb.de

Development Status

TRL3 - Proof of concept

Patent Situation

DE 60201 062535.3 granted
EP 3410184 B1 (FR,GB) granted
US 10,593,873 B2 granted

Reference ID

16/059TLB

Service

Technologie-Lizenz-Büro GmbH has been entrusted with exploiting this technology and assisting companies in obtaining licenses.

Background

The use of optical nano resonators opens up a new dimension of miniaturization of photonic elements. In many areas, the technological development has already taken a new nano-dimension thanks to today's meta-surfaces; their production is becoming ever easier and cheaper.

By using a staggered meta-surface on a substrate of phase change material, multiple functionalities can now be integrated into a single element and switched independently. It is also possible to address these functionalities, like beam steering, using any angle, ultra-fast and at nano scale. The combination of plasmonic and dielectric resonances now allows for variable focusing of mid-infrared radiation in a single, highly integrated component.

Problem

At very small scales, it is no longer possible to implement mechanical concepts for beam steering. Highly integrated, miniaturized beam deflection can be achieved by combining phase transition materials and Fabry-Pérot resonators – but these concepts are limited to narrow-band wavelength ranges. Other implementations are extremely temperature-sensitive. So far, none of them has succeeded in integrating a range of functionalities into one element.

Solution

The concept of staggered meta-surfaces, i.e. a combination of meta-surfaces of different designs (more precisely different resonator structures), allows different functionalities to be integrated into one single element. Depending on their size, the resonator structure interacts only with certain wavelengths and can therefore be stimulated separately. The phase change material $Ge_3Sb_2Te_6$ (PCM GST-326) serves as a substrate. It can be activated electrical and optical to change the refractive index so that the desired meta-functionality can be selected.

The nano resonators, which react highly sensitively to their dielectric environment, subsequently change their respective resonance wavelength.

The concept of this highly functional component layer ('Active Plasmonic Nanophotonic Components' (APNPCs)) has already been successfully tested under laboratory conditions. It can be individually adapted to its intended use depending on the materials used (substrate and its possible states as well as the selection of resonator structures).

Publikationen und Verweise

"Beam switching and bifocal zoom lensing using active plasmonic metasurfaces".
Yin, X., Steinle, T., Huang, L. *et al.*,
Light Sci Appl 6, e17016 (2017),
doi.org/10.1038/lsa.2017.16